INSTRUCTION MANUAL

TYPE G PLUG-IN

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

TYPE G PLUG-IN

Ser. No. 11001

Tektronix, Inc.
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Tektronix International A.G.
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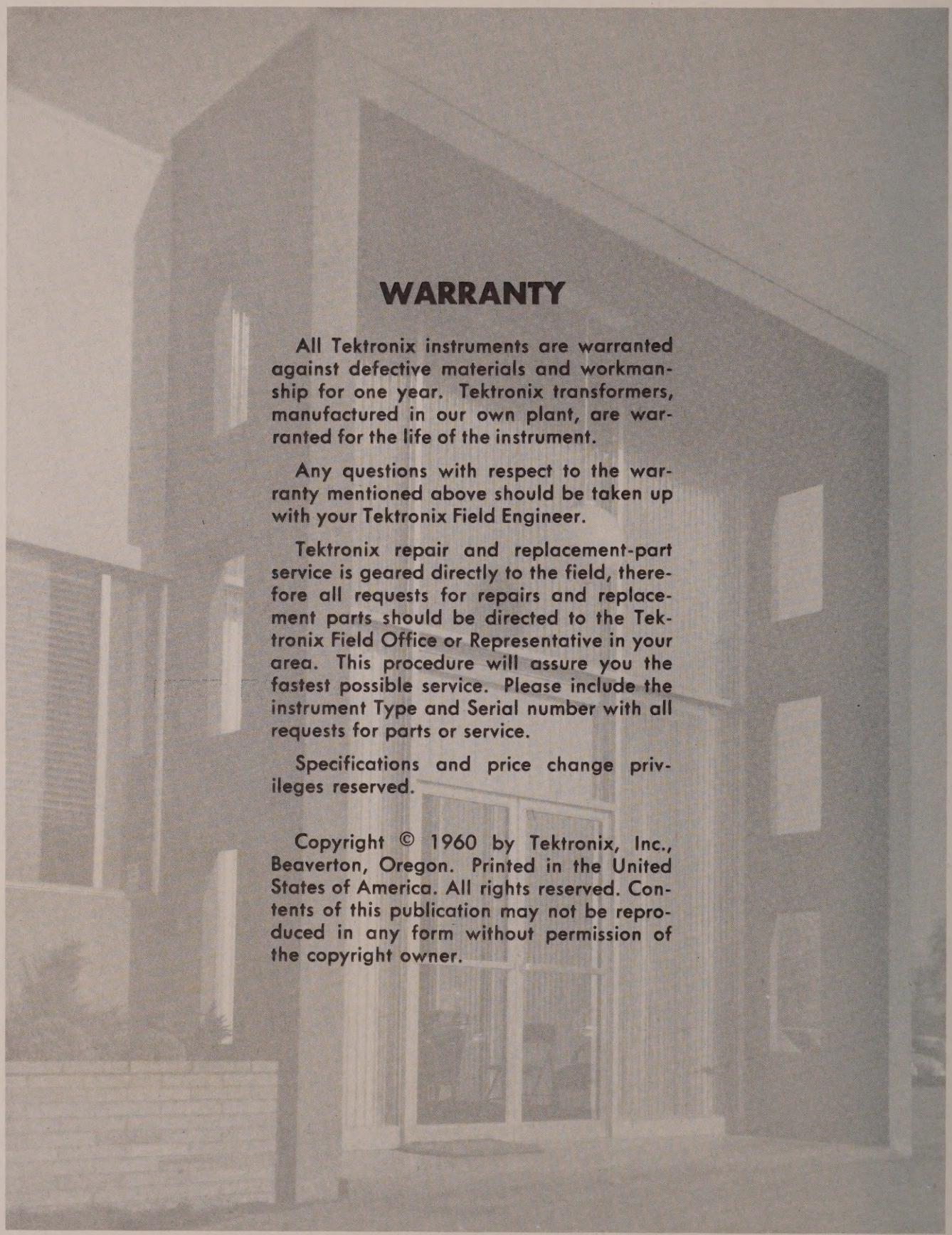

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

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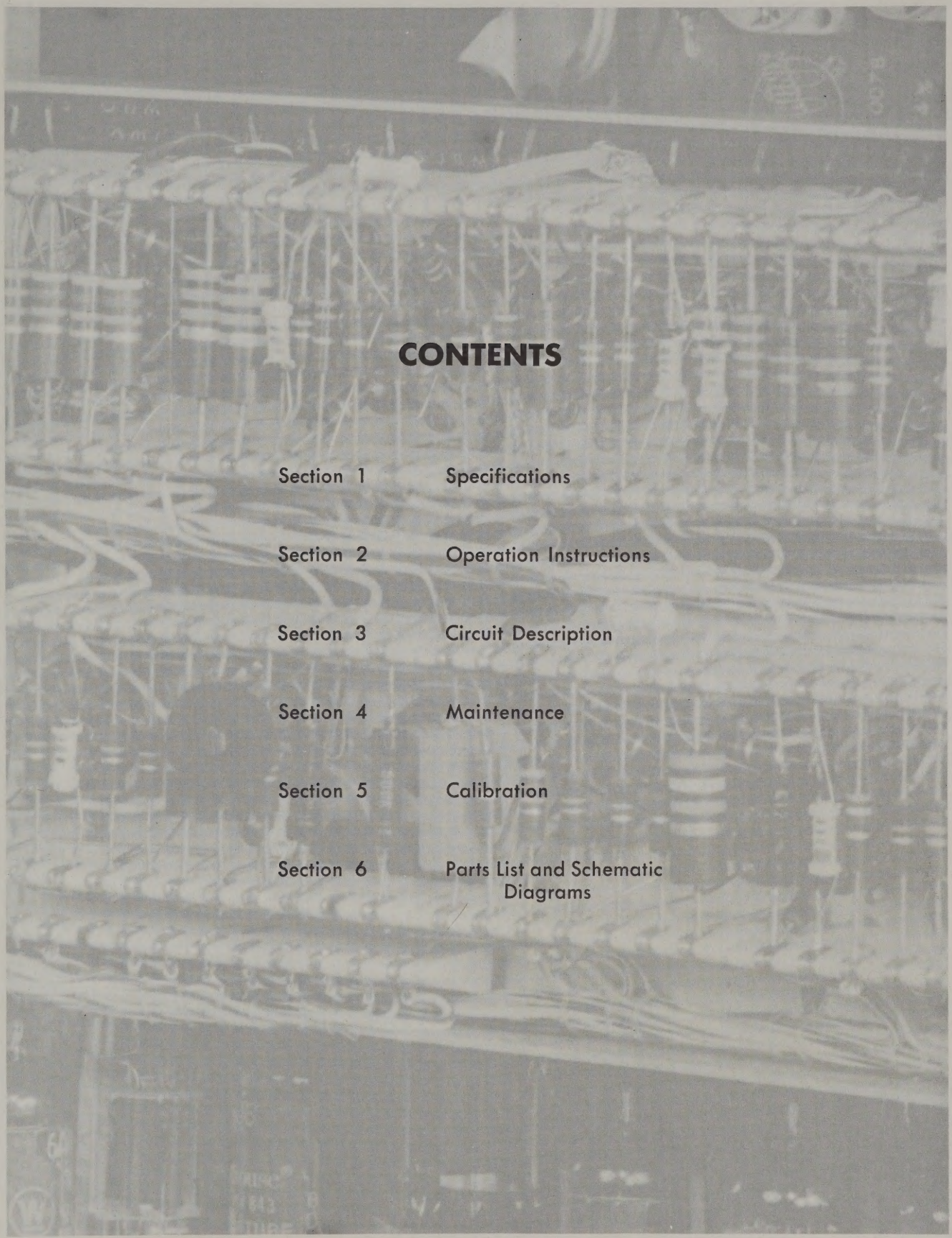

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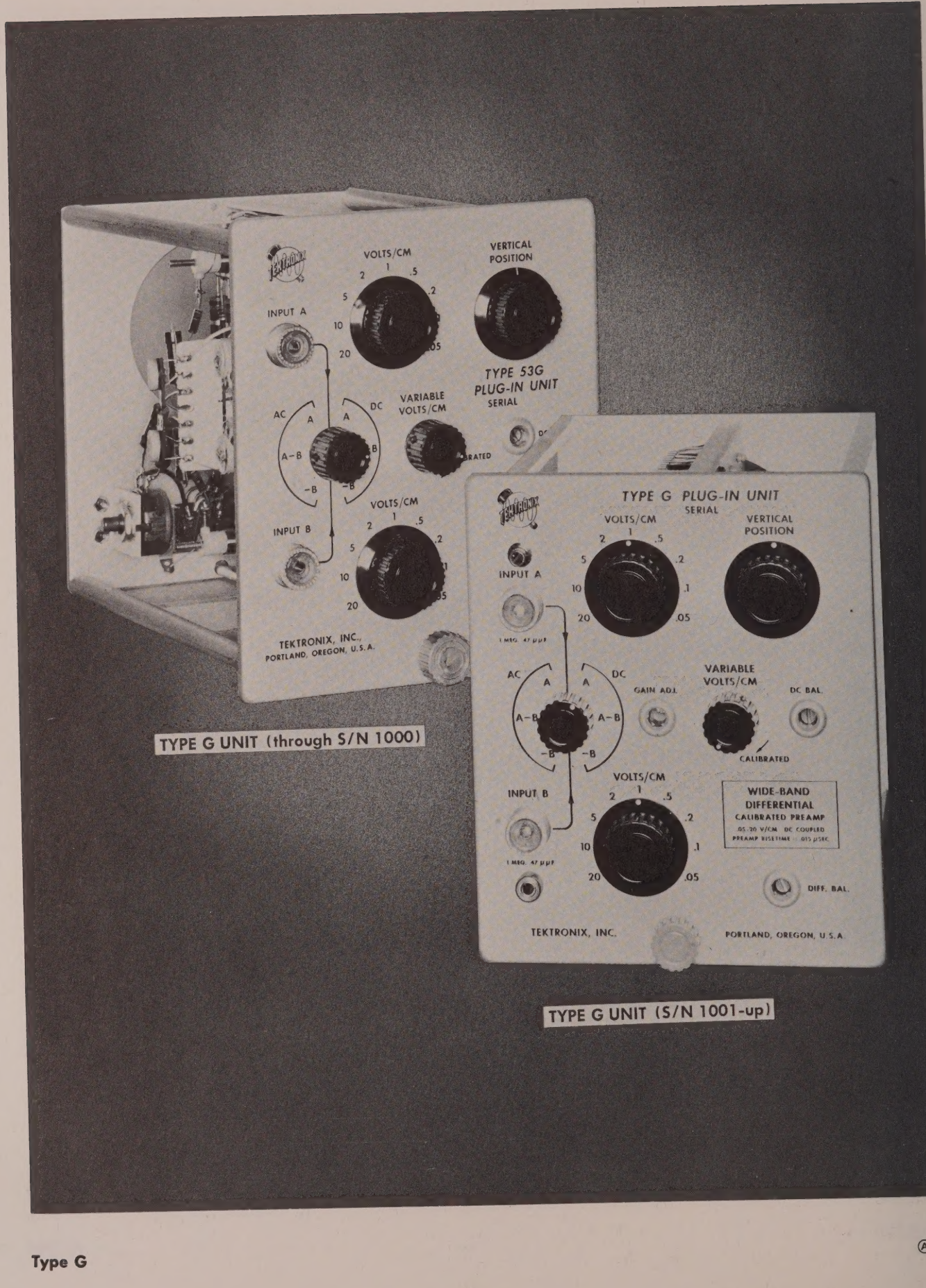
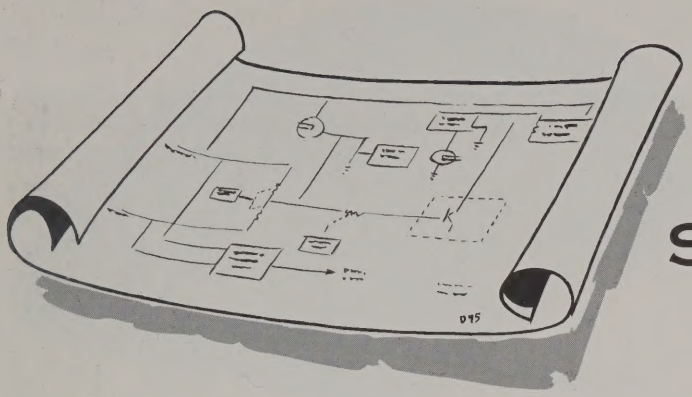


TYPE G UNIT (through S/N 1000)

TYPE G UNIT (S/N 1001-up)



SECTION 1

SPECIFICATIONS

GENERAL

The Type G Unit is suited to work requiring differential input and high rejection ratio. It has wide band pass and good transient response. It may be used with Tektronix Type 530, 540, 550, and 580 series oscilloscopes. For use with Type 580 Series Oscilloscopes a Type 81 Plug-In Adapter must be used. The differential input permits cancellation of unwanted or interfering signals.

The Plug-In Unit that was first known as Type 53G and then changed to Type 53/54G, and finally to Type G Plug-In unit, will be called Type G Plug-In Unit throughout the balance of the manual. This designation is for simplification in compositing the information of all the Types.

TYPE G SPECIFICATIONS

Frequency Response

Passband—DC to 20 mc with Types 541, 541A, 543, 545, 545A, 555, and the 580-Series using 81 adapter.

Passband—DC to 10 mc with Type 531, 535 and 536.

Passband—DC to 5 mc with Type 532.

Passband—DC to 14 mc with Type 531A, 533, and 535A.

Passband—DC to 18 mc with Type 551.

(Down not more than 3 db at above limits).

Transient Response (10% to 90%)

Risetime—.015 μsec Plug-In Amplifier.

Risetime—.025 μsec with Types 531A, 533, and 535A.

Risetime—0.07 μsec with Type 532.

Risetime—.035 μsec with Types 531, 535, and 536.

Risetime—.018 μsec with Types 541A, 543, 545A, 555, and 580-Series with Type 81 Adapter.

Risetime—0.02 μsec with Type 551.

Deflection Factor

Calibrated—.05 v/cm to 20 v/cm.

Continuously Variable—.05 v/cm to 20 v/cm.

Step Attenuator

Nine positions, calibrated, from .05 v/cm to 20 v/cm, accurate within 3% when set on any one step. Independent step attenuator in each input with 80 db isolation. This permits mixing of signals of wide amplitude difference.

Maximum Allowable Combined DC and Peak AC Input Voltage—600 v.

Larger signals must be externally attenuated.

Differential Input

100-to-1 rejection ratio at full gain for any in-phase signal within the pass band of the instrument and better than 300-to-1 rejection ratio for 60 cycles per second; maximum amplitude handling capability, 2 volts, peak-to-peak, between the input grids of the input amplifier tubes.

Input Impedance

Plug-In Unit	1 megohm, 47 μμf
With P410 Probe	10 megohms, 11 μμf
With P510 Probe	10 megohms, 14 μμf
With P6000 Probe	10 megohms, 14.5 μμf

Mechanical

Construction—Aluminum-alloy chassis.

Finish—Photo-etched anodized panel.

Weight—4½ lbs.

FUNCTIONS OF FRONT-PANEL CONTROLS AND CONNECTORS

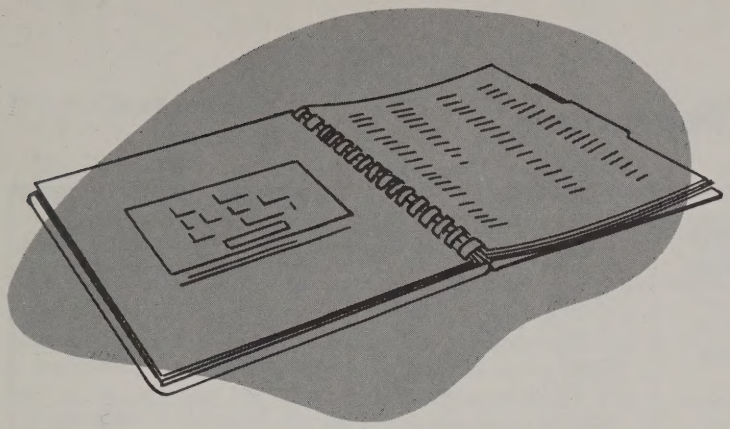
INPUT A INPUT B	Separate signal inputs to the preamplifier by way of the INPUT SELECTOR switch.	VOLTS/CM	Two 9-position switches, one in each input circuit, to select the desired deflection factor.

INPUT SELECTOR SWITCH	Six-position switch, to select either input separately or the two inputs differentially, with either ac or dc coupling.
VARIABLE (volts/cm)	Control to vary the gain over a range of about 2½ to 1.
VERTICAL POSITION	Control to position the trace vertically.
GAIN ADJ. (S/N 1917-up only)	Screwdriver control to adjust the basic gain of the amplifier.
DC BAL.	Screwdriver adjustment to set the dc voltage across the VARIABLE VOLTS/CM control to zero so the trace does not shift when the gain is varied.
DIFF. BAL.	Screwdriver control to provide a fine differential adjustment of the input amplifier gain for maximum rejection of the common-mode signal.

Accessories

2—Instruction Manuals

SECTION 2



OPERATING INSTRUCTIONS

General

The Type G Plug-In Unit is designed to operate as a preamplifier for a Tektronix 530-Series, 540-Series, 550-Series, and Type 81 Adapted 580-Series Oscilloscope. We assume that it will be operated in that manner in the following instructions.

Input Connections

Be careful when you make connections to the preamp INPUT connectors that the external circuitry does not cause deterioration of the waveform. Improper termination of cables may cause ringing or loss of frequency response. If you use unshielded leads, keep them short as possible to minimize hum. Leads which pass near the cathode-ray-tube screen may pick up some ripple from the high-voltage power supply. If this occurs, try relocating the leads or use additional shielding.

Either of the two signal inputs can be used independently by turning the INPUT SELECTOR switch to A or —B and connecting the signal to the corresponding input connector. The signal will be inverted when connected to INPUT B. Each input presents a load of 1 megohm shunted by 47 $\mu\mu$f to the signal source.

CAUTION

No combined AC and DC input voltages should exceed 600 volts peak.

The DC and AC positions of this switch differ only in that, in the AC positions, a capacitor is inserted in series with the input to remove the dc component of the signal. In the AC position, the capacitor that is inserted limits low frequency response to 3 db down at 2 cycles. When the switch is in either position marked A-B, both inputs are connected to the amplifier through individual compensated attenuators. The signal presented to the oscilloscope amplifier will be the difference between these two signals after attenuation. This makes it possible to balance out a large signal with a relatively small one, or vice versa, by appropriate selection of deflection facotrs.

Probe Information

Early Type G Units were furnished with P400-series or P500-series probes. P500-series probes are usable in the range from DC to 10 megacycles. P400-series probes should be used with 540- and 550-series oscilloscopes, where frequencies in excess of 10 megacycles are likely to be encountered.

P400-series probe bodies are 3/4-inch in diameter. They are molded of fiberglass-reinforced alkyd and have an internal brass shield. Noses are color-coded to indicate attenuation ratios. Length is 3-3/4 inches without tip. Two Tektips were furnished with each probe—a straight tip and freely-rotating hooked tip. The tips increase probe length by about one inch, adding less than 0.5 $\mu\mu$f to the input capacitance. P400-series probes have a 42-inch coaxial cable with uhf connector.

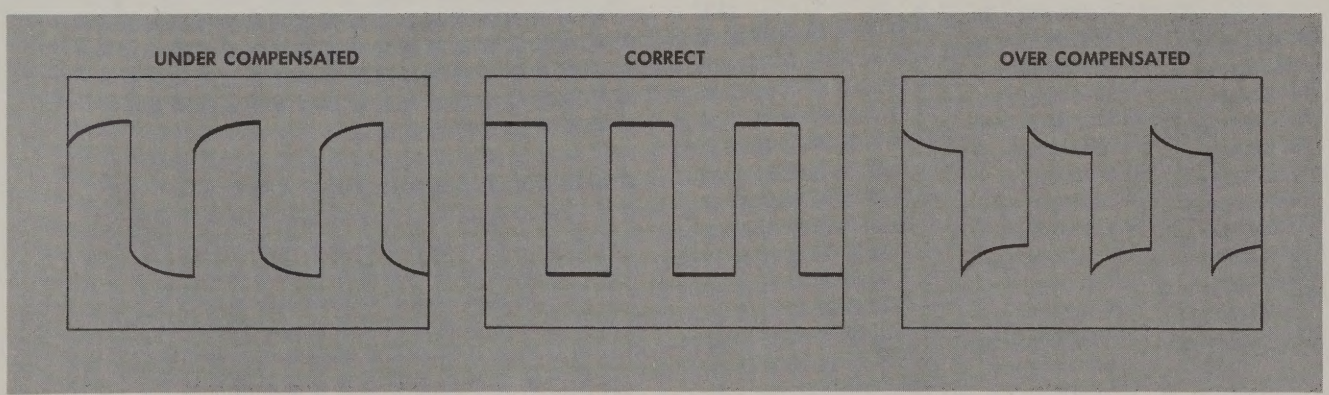


Fig. 2-1. Probe square wave compensation.

PROBE SPECIFICATIONS

PROBE TYPE	COLOR CODE	ATTENUATION RATIO	INPUT IMPEDANCE			INSERTION LOSS AT 30 mc (db)	VOLTAGE RATING (Peak-to-Peak)
			Resistance (megohms)	Typical Capacitance			
				Minimum*	Maximum**		
P405	Green nose	5:1	5	12 μμf 21 μμf†	19 μμf 30 μμf†	1-2	600
P410	Brown nose	10:1	10	8 μμf 12 μμf†	11 μμf 15 μμf†	1	600
P420	Red nose	20:1	10	5.5 μμf 8 μμf†	7 μμf 9 μμf†	1	600
P450	Clear nose Green inside	50:1	10	3.5 μμf 4 μμf†	3.5 μμf 4 μμf†	1	1000
P450-L‡	Clear nose; Green inside	50:1	10	2.5 μμf 3 μμf†		1	1000
P510	Black nose	10:1	10		14 μμf	1	600
P4100	Clear nose	100:1	10	2.5 μμf 3 μμf†	2.5 μμf 3 μμf	1	1000
P6000	None	10:1	10	11.5 μμf	14.5 μμf	1.2	600
P6014	None	1000:1	100		3 μμf		25000
P6017	None	10:1	10	12.5 μμf	12.5 μμf	1	600

* When connected to instruments having 20 μμf capacitance (input).

** When connected to instruments with input capacitance up to 50 μμf.

† With 8-foot cable.

‡ Will not adjust to instrument having over 25 μμf input capacitance.

Probe Adjustment

An adjustable capacitor compensates for slight variations in input capacitance from one instrument to another. This capacitor is located in the probe body in the P405, P410, P420, and in the termination block at the instrument end of the cable in the P450, P450-L and P4100. It takes only a few seconds to check this adjustment, and it is a good practice to make this check each time the probe is to be used. Simply touch the probe to the oscilloscope calibrator-output terminal and observe the calibrator waveform on the screen. If necessary, adjust the trimmer for a flat top on the calibrator square wave (see Fig. 2-1). For critical adjustment of the P4100, a faster-rising square wave, such as the output of the Tektronix Type 104A or Type 105, should be used.

The Type P6000 probe may be used with either the 530- or 540-Series Oscilloscopes. Be sure to check the adjustment of the probe when you first connect it to the plug-in. Touch the probe tip to the calibrator output connector and display several cycles of the calibrator waveform. If the top and bottom of the displayed waveform is not flat, loosen the locking ring by turning it in a counterclockwise direction. Rotate the barrel of the probe as necessary to compensate the probe. Tighten the locking ring carefully after compensating the probe, being careful not to disturb the probe adjustment.

P400-Series Low-Capacitance Probes

This series of low-capacitance probes preserves the transient response of Tektronix fast-rise instruments. The P400-Series probes are free of overshoot and ringing and have relatively uniform high-frequency response. Input capacitance and insertion loss are affected by cable length. With cables up to 12' in length, insertion loss is less than 3 db at 20 mc, and overshoot is less than 1%. With exception of the P450-L, these probes can be used on those instruments having input capacitances from 20 to 50 μμf. General physical characteristics of the P400-Series probes are identical to the P510A probe. Color-coding of the plastic nose indicates attenuation ratio. Two interchangeable Tek-tips, a straight tip and a hooked tip, each adding less than 0.5 μμf to the input capacitance, and an alligator clip assembly are supplied with each probe.

Preventive Maintenance

Regular inspection of the nose and cable fastening screws will help prevent possible mechanical damage due to twisting. A small nylon screw holds the nose in place, and an allen setscrew grips the cable firmly. Tighten these screws if they work loose.

Probe Repair (Type 410 or 510)

To disassemble, remove the nylon screw and loosen the allen setscrew. Slide the probe body back over the cable. Examine the layout carefully before proceeding. The center conductor of the cable is extremely fragile—be careful not to break it when removing a probe part. Replacement parts can be obtained through field offices or directly from the factory. When resoldering, it is important to get a good connection between the probe resistor and the center conductor of the cable. Reassemble the probe and tighten the screws.

Probe Characteristics

Use of probes may reduce the specified Common-Mode Rejection ratio to approximately 50 to 1 at full gain and even less at reduced sensitivities. The one-percent tolerances of the resistors in the probe and attenuators cause this decrease in rejection ratio.

Be sure to check the adjustment of the probe when you first connect it to a plug-in unit. The probe compensation is a function of the input capacitance of the particular plug-in unit or oscilloscope with which you use the probe. If the compensation is incorrect, the frequency response will be affected.

Touch the probe tip to the calibrator output connector and display several cycles of the calibrator waveform. If the top and bottom of the displayed square wave are not flat, adjust the trimmer capacitor located either inside the probe body or inside the box at the other end of the cable to achieve correct square-wave response.

Coupling

It is sometimes unnecessary or undesirable to display the dc level of the waveform. In the two AC positions of the INPUT SELECTOR switch, a capacitor in series with the input blocks the dc component of the waveform so that only the ac component is displayed.

Deflection Sensitivity

The VOLTS/CM switch controls the vertical deflection factor in accurately calibrated steps. The VARIABLE control provides continuous adjustment of the deflection factor.

NOTE

The VARIABLE control must be clockwise to the CALIBRATED position for the deflection factor to be as indicated by the VOLTS/CM control.

Differential Input

The differential input makes possible the application of balanced signals to the G preamp. The best rejection ratio for common mode signals is obtained in the unattenuated (maximum gain) position. When a balanced input is required, be sure both VOLTS/CM switches are on the same deflection factor position.

Sometimes it is desirable to use different deflection factors on the two inputs. You can buck out 60-cycles hum in a signal being viewed by applying a properly phased 60-cycle signal to the unused input. If variable attenuation is necessary this must be done externally. You can buck out up to 600 volts dc by connecting a battery to the unused input. You should not exceed 4 volts input when in the maximum gain position or at the input grid after attenuation.

Differential-Balance Adjustment

The DIFF. BAL. control balances the amplifiers so that when the same signal is connected to both inputs, the output signal is reduced to a minimum. To adjust the DIFF. BAL. control connect a two-volt signal from the calibrator to both INPUT A and INPUT B without the probes connected. Set the INPUT SELECTOR switch to A-B. Set both VOLTS/CM controls to .05. Adjust the DIFF. BAL. control to obtain a straight line on the screen.

The rejection ratio for a balanced input is reduced when the probes are used or when the VOLTS/CM switches are in positions other than for maximum deflection factor. This is caused by the one-percent tolerances of the resistors in the attenuators and input circuits. The rejection ratio can be improved for lower deflection factors by setting the DIFF. BAL. control for the specific position on the VOLTS/CM switch that is to be used. Connect the calibrator to both inputs simultaneously with a convenient calibrator output voltage for the deflection factor to be used. Set the INPUT SELECTOR switch on A-B, and adjust the DIFF. BAL. control for minimum signal. It should be possible to pass through a minimum with the DIFF. BAL. control.

Gain Adjustment

Aging of tubes will affect the gain of the plug-in unit. After the plug-in unit has been in use for a period of time, the gain adjustment should be checked. Display a calibrator waveform of .2 volts peak-to-peak with the VOLTS/CM switch in the .05 position of Input A. Adjust the GAIN ADJ. (see Fig. 2-2. Control is on bottom of unit through S/N 1000) control until the displayed waveform is four graticule divisions in amplitude. Be sure the VARIABLE control is turned clockwise to the CALIBRATED POSITION before making this adjustment.

DC Balance Adjustment

The need for adjustment of the DC BAL. control is indicated by a shift in the position of the trace as the VARIABLE control is rotated. This is caused by tube aging. This adjustment should be made after the GAIN ADJ. control is set. Rotate the VARIABLE control back and forth and adjust the DC BAL. control until the trace position is no longer affected by rotation of the VARIABLE control.

Positioning Adjustment

The Vert. Pos. Range control balances the dc output level so the full range of the front-panel positioning control can be utilized. The Vert. Pos. Range control is located at the left to the rear of the plug-in unit and is accessible when the left side panel is removed. Remove the calibrator signal. Center the VERTICAL POSITION control. Adjust the Vert. Pos. Range control to center the trace on the screen.

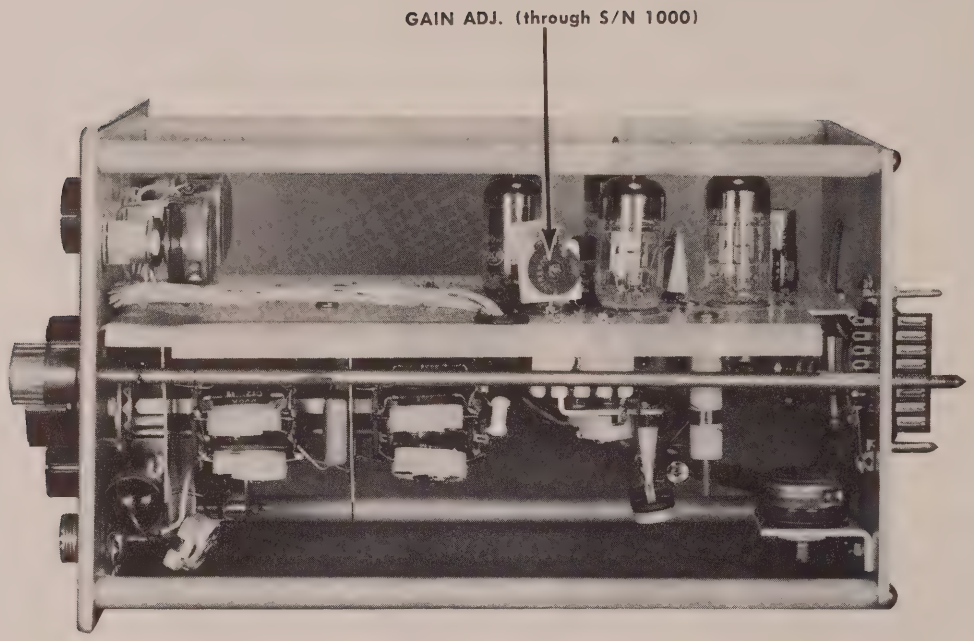
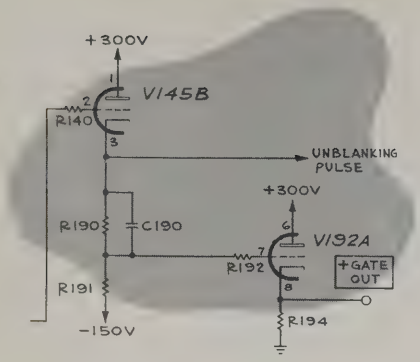


Fig. 2-2. Location of GAIN ADJUST for S/N 101 through 1000.



SECTION 3

CIRCUIT DESCRIPTION

General

The Type G Plug-In Unit has a maximum deflection factor of 0.05 volts/cm. The circuit consists of two stages of amplification with each stage followed by cathode followers (input cathode follower precedes first stage S/N 1001-up).

Input Connectors

The INPUT SELECTOR switch, SW3027 (SW3017 S/N 1001-up), connects the two input connectors to the grids of the input amplifiers (input cathode follower S/N 1001-up). In either the A or —B positions of the switch, one of the grids is grounded and the other is connected to its associated input connector. The tube whose grid is grounded is cathode driven. This configuration at the first input stage assures push-pull amplification from the single-ended input signal. In the A-B positions, both grids are connected to the signal inputs. Blocking capacitors C3017 and C3027 (C4017 S/N 1001-up) are shorted out in the DC positions of the selector switch. They permit AC flow of current but block out the DC flow when they are in the circuit.

Input Attenuators

The VOLTS/CM switches, SW3057 and SW3067 (SW3347 and SW4347 S/N 1001-up), insert frequency-compensated attenuators into the input circuits. Four (five, S/N 1001-up) attenuators in each switch are used singly or in tandem pairs to produce nine deflection factors. The attenuators have voltage attenuation ratios of 2X, 4X, 10X and 100X (1X S/N 1001-up) to produce deflection factors in volts per centimeter of deflection of 20, 10, 5, 2, 1, .5, .2, .1, and .05. When properly adjusted, the input resistance and capacitance remains unchanged as the attenuators are inserted. The X1 attenuation network (S/N 1001-up) compensates for lead inductance in the input circuits.

Input Cathode Followers (S/N 1001-up)

Input cathode followers, V3347 and V4347, isolate the input amplifier from impedance changes caused by the different attenuator steps. When a single input is used, the grid of the opposite cathode follower is grounded. This opposite cathode follower is cathode driven when the signal is applied to the grid-driven section. The input cathode followers are dc-coupled to the input amplifiers. R3317 and R4317 are current-limiting resistors to limit grid current in the event an excess voltage is applied to the input.

Input Amplifier

The input amplifier, V3477 and V3487 (V3457 and V4457 S/N 1001-up), is a common-cathode phase-splitter amplifier. R3397 and R3407 (through S/N 1000) are current-limiting resistors such as R3317 and R4317. V3457 and V4457 (S/N 1001-up) operate as a push-pull amplifier when a push-pull signal is applied to the input. The DIFFerential BALance control, R3537 (R3547 S/N 1001-up), varies the voltage on the suppressor grids, raising one as it lowers the other. This increases the gain in one tube while decreasing the gain of the other. In this way the amplifier is adjusted for maximum rejection of the common-mode signal. The GAIN ADJ. control sets the gain so that the stage agrees with the front panel calibration.

The following conditions exist in instruments bearing Serial Number 1001 and higher. The GAIN ADJ. control, R3747B, adjusts the gain of the stage to agree with the front-panel calibration. This control is mounted on the same shaft as R3747A. Inductors L3467 and L4467 provide high frequency peaking for this stage of amplification. V3457 and V4457 obtain their plate supply from the heater string through the load resistors R3467 and R4467.

Cathode Follower (through S/N 1000)

Through S/N 1000, a cathode-follower stage (V3617B and V3627A) follows the input amplifier and provides a low-impedance drive for the output amplifiers. The input capacitance of the output amplifier varies as the gain controls are varied. The cathode-follower stage prevents this change of capacitance from affecting the high-frequency response. C3557 and C3567 feed back the high-frequency components of the signal from each cathode to the grid of the opposite input amplifier. These capacitors are set to neutralize the grid-to-cathode capacitance of the input amplifiers. This prevents a high-frequency loss when the grid which is not being driven is at a high-impedance level.

DC Balance

The DC BALance control (R3767, through S/N 1000 and R3757, S/N 1001-up) makes the cathode of one output amplifier tube at the same dc potential as the other output amplifier. The Type G Plug-In Units with S/N 366 through 1000 and S/N 1692-up do this by providing an adjustable dc grid voltage for one output amplifier tube. The DC BALance control in the units with S/N 101 through 365 and S/N 1001 through 1691 balances the cathode dc potential of the output amplifier tubes. When the control is properly set, no change in vertical positioning results when the VARIABLE VOLTS/CM control is rotated.

Output Amplifier

The output amplifier, V3617A and V3627B (V3657 and V4657 S/N 1001-up) is a common cathode amplifier. This stage amplifies the signal a second time and provides variable gain and positioning facilities. Inductors L3677 and L3687 (L3617 and L4617 S/N 1001-up) form peaking networks in the plate circuit. Resistor R3607 and resistors R3617 and R4617 (S/N 1001 and up) provide plate load resistance for the amplifier plates.

The VARIABLE VOLTS/CM control, R3717, varies the gain over a $2\frac{1}{2}$ to 1 ratio by varying the degeneration in the cathode circuit. The GAIN ADJ. control, R3727 (R3747 SN 1001-through S/N 1916) (R3747A S/N 1917-up), varies the total cathode current in this stage to set the gain to agree with the front-panel calibration.

The VERTICAL POSITION control, R3827 (R3857 S/N 1692--up), is a dual potentiometer that positions the trace vertically. It is connected so that current is increased in one plate load as it is decreased in the other. A second dual potentiometer, R3887 (S/N 1001-up) is the vertical position range control that allows the trace to be centered when the VERTICAL POSITION control is centered. Since the amplifier is dc coupled beyond this point, the change in plate voltage which occurs changes the position of the trace on the cathode-ray tube.

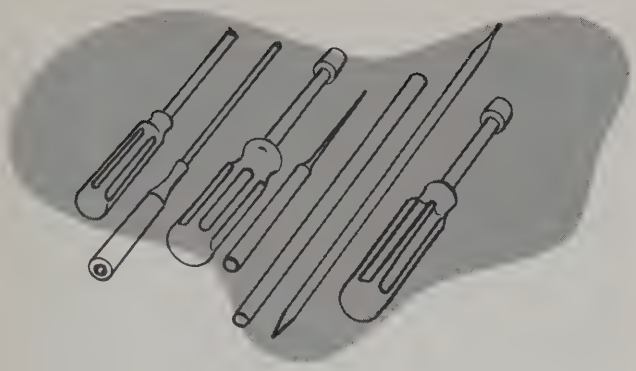
Output Cathode Followers

Through S/N 1000 there are frequency-compensated dividers that reduce the dc potential applied to the cathode-follower grids to the correct value for the input of the Type 530-Series Oscilloscopes. The cathode followers, V3967, (V3947 S/N 1001-up), produce the low impedance necessary to drive the capacitance of the interconnecting plug and the main-amplifier circuit.

From S/N 1001-up, the cathode-follower circuit is modified by resistors in the plate circuits and by capacitors cross-connected from the plates to the opposite cathodes. This modification improves the high-frequency balance of the plug-in unit.

The H.F. Peaking control, R3987 (S/N 1001-up), varies the current in the cathode followers. This changes the impedance at the cathodes and changes the effect of the series peaking coils, L3957 and L3967 (L3977 and L4977 S/N 1001-up), tied to these cathodes.

SECTION 4



MAINTENANCE

PREVENTIVE MAINTENANCE

Visual Inspection

You should visually inspect the Type G Plug-In Unit periodically for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles, the remedy is readily apparent; however, particular care should be taken when heat-damaged parts are found. Overheating of parts is often the result of other, less apparent defects in the circuit. It is essential that you determine the cause of overheating before you replace the heat-damaged part in order to prevent further damage.

Recalibration

The Type G Plug-In Unit is a stable instrument that will provide many hours of trouble-free operation. However, in order to insure the proper operation at all times, it is suggested that the unit be recalibrated after each 500 hours of operation (or every six months if the unit is used intermittently). Complete recalibration procedures are given in Section 5.

COMPONENT REPLACEMENT

General Information

Procedures required for replacement of most parts in the Type G Plug-In Unit are obvious. Detailed instructions for their removal are therefore not required. In some cases, additional information will aid in the replacement of parts. This information is given in the following paragraphs. Because of the nature of this instrument, it will be necessary to calibrate portions of the instrument after part replacement. Refer to the Calibration Section of this manual for the procedures involved.

Replacement of Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is needed. Single wafers are normally not replaced. If one wafer is defective, the entire switch should be replaced. Switches may be ordered from Tektronix either wired or unwired as desired.

SOLDERING AND CERAMIC STRIPS

Many of the components in your Tektronix instrument are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one-pound rolls. Order by Tektronix part number 251-514.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 4-1 will show you the correct shape for the tip of the soldering iron. Be sure and file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

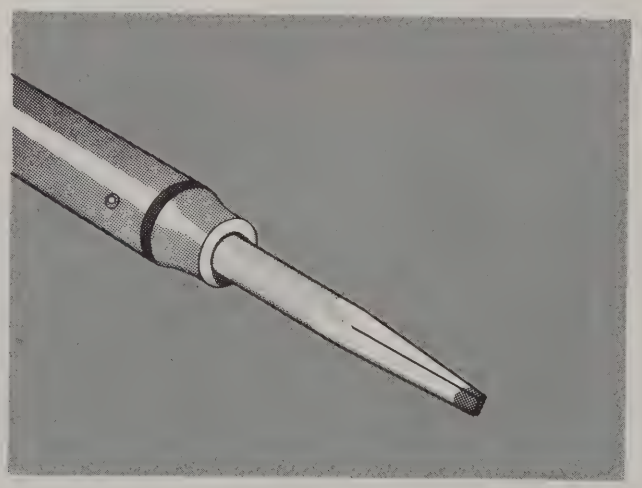


Fig. 4-1. 60 watt soldering iron and tip.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.
2. Prepare the tip of the iron as shown in Fig. 4-1.
3. Tin only the first 1/16 to 1/8 inch of the tip. For solder to ceramic terminal strips tin the iron with solder containing about 3% silver.
4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 4-2).
5. Apply only enough heat to make the solder flow freely.
6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Figure 4-3.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be soldered as shown in Figure 4-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed as shown in Figure 4-3.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Figure 4-5. In soldering to terminal pins mounted in plastic rods it is necessary to use some form of "heat sink" to avoid melting the plastic. A pair of long-nosed pliers (see Figure 4-6) makes a convenient tool for this purpose.

Ceramic Strips

Two distinct types of ceramic strips have been used in Tektronix instruments. The earlier type mounted on the chassis by means of #2-56 bolts and nuts. The later type is mounted with snap-in, plastic fittings. Both styles are shown in Figure 4-7.

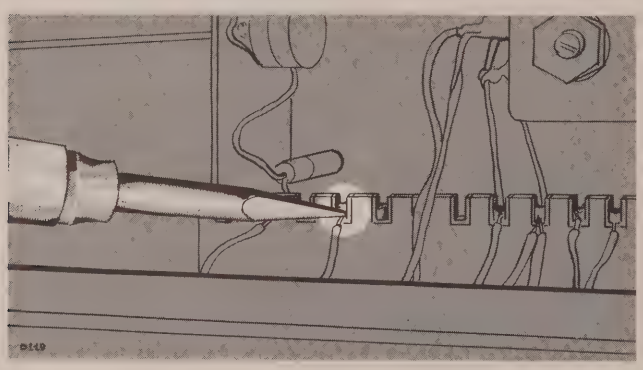


Fig. 4-2. Method of applying tip to strip.

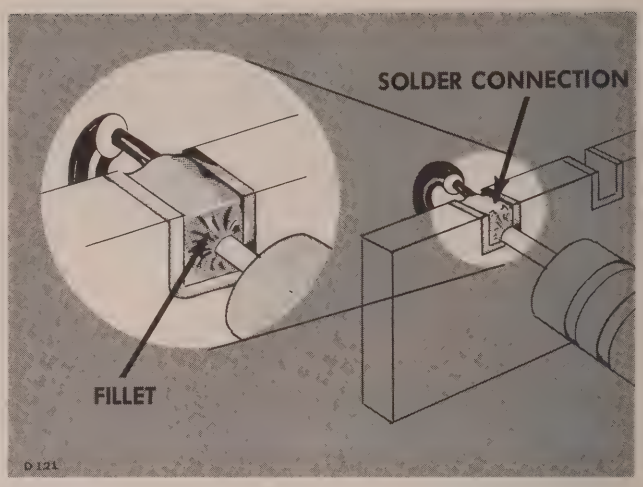


Fig. 4-3. Proper soldering fillet.

To replace ceramic strips which bolt to the chassis, screw a #2-56 nut onto each mounting bolt, positioning the nut so that the distance between the bottom of the nut and the bottom of the ceramic strip equals the height at which you wish to mount the strip above the chassis. Secure the nuts to the bolts with a drop of red glyptal. Insert the bolts through the holes in the chassis where the original strip was mounted, placing a #2 starwasher between each nut and the chassis. Place a second set of #2 flatwashers on the protruding ends of the bolts, and fasten them firmly with another set of #2-56 nuts. Place a drop of red glyptal over each of the second set of nuts after fastening.

Mounting Later Ceramic Strips

To replace ceramic strips which mount with snap-in plastic fittings, first remove the original fittings from the chassis. Assemble the mounting post on the ceramic strip. Insert the

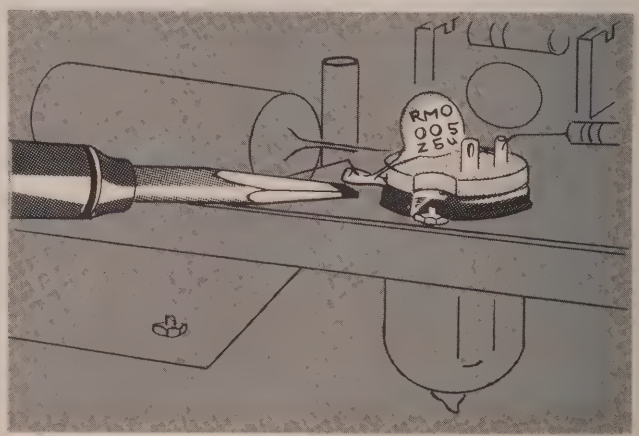


Fig. 4-4. Soldering to metal terminals.

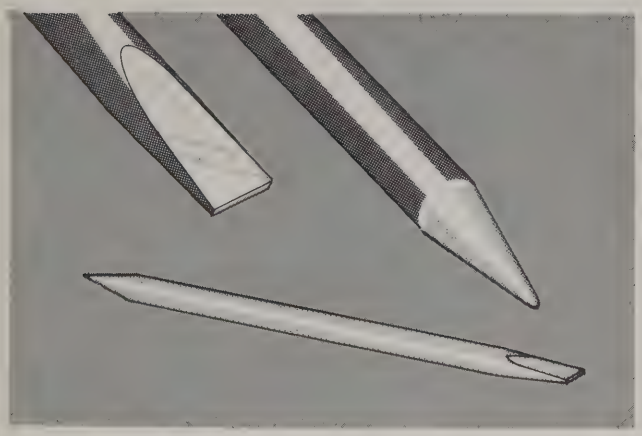


Fig. 4-5. Wooden dowel for soldering aid.

nylon collar into the mounting holes in the chassis. Carefully force the mounting posts into the nylon collars. Snip off the portion of the mounting post which protrudes below the nylon collar on the reverse side of the chassis.

Note: Considerable force may be necessary to push the mounting rods into the nylon collars. Be sure that you apply this force to that area of the ceramic strip directly above the mounting rods.

REPLACEMENT PARTS

Standard Parts

Replacement for all parts used in the Type G Plug-In Unit can be purchased directly from Tektronix at current net prices. However, since most of the components are standard electronic parts, they can generally be obtained locally in less time than required to get them from the factory. Before ordering or purchasing parts, be sure to consult the parts list to determine the tolerances and ratings required. The parts list gives the values, tolerances, ratings, and Tektronix part numbers for all components used in the instrument.

Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, special parts are also used in the assembly of the Type G Plug-In Unit. These parts are manufactured or selected by Tektronix to satisfy particular requirements or are manufactured specially for Tektronix by other companies in accordance with Tektronix specifications. These parts and most mechanical parts should be ordered directly from Tektronix since they are normally difficult or impossible to obtain from other sources. All parts may be obtained from the factory or through the local Tektronix Field Office.

TROUBLESHOOTING

Introduction

This section is included to provide you with information about the G Unit that will enable you to more efficiently troubleshoot the unit in the event that trouble develops.

Troubleshooting of plug-in units is somewhat complicated by the need to determine whether the trouble observed is in the plug-in unit or the oscilloscope. Many troubles can be quickly isolated by substituting another plug-in and looking for the same symptoms. Among the troubles which fall into this category are insufficient gain, inability to position the trace, noise, unbalance, and severe waveform distortion. Minor waveform distortions such as might be caused by high-frequency peaking coils or delay-line trimmers can be isolated by this method, only by substituting another plug-in unit of equal or superior bandwidth and checking for the same distortion.

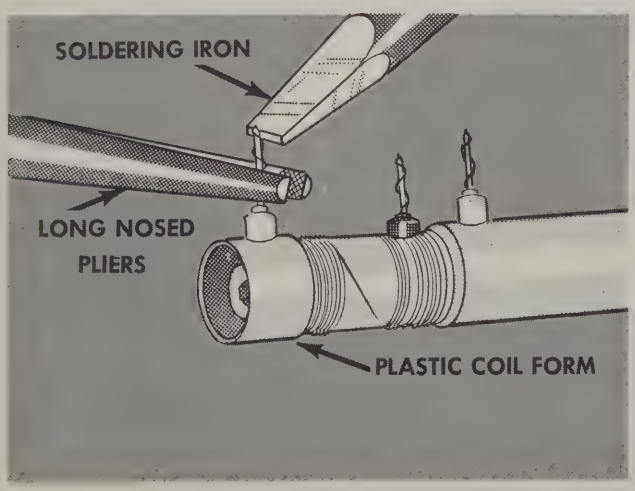


Fig. 4-6. Long-nosed pliers as "heat sink".

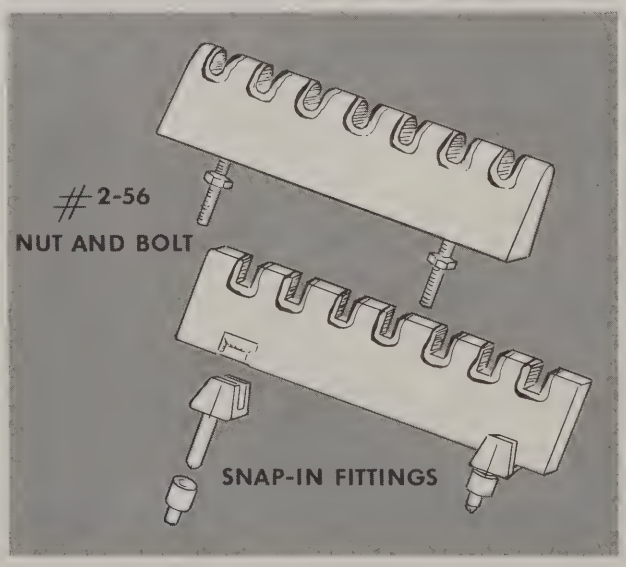


Fig. 4-7. Ceramic strips and fittings.

Noise and unbalance problems can also be isolated by connecting a jumper from pin 1 to pin 3 of the interconnecting plug. If the trouble remains, it is probably not in the plug-in unit.

Most troubles are caused by tube failures and you can frequently find them by finding the bad tube and replacing it with a good one. It is a good practice to inspect components in the circuit with the bad tube for possible overheating as a result of the tube failure. One way to find bad tubes is to try replacing suspected tubes with good ones.

A schematic diagram of the G Unit is contained in the rear portion of this manual. The reference designation of each section is shown on the circuit diagram as well as important voltages. These voltages should be used as troubleshooting aids.

Switch wafers shown on the schematic diagram are coded to indicate the position of the wafer on the actual switch. The number portion of the code refers to the wafer number on the switch assembly, wafers being numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

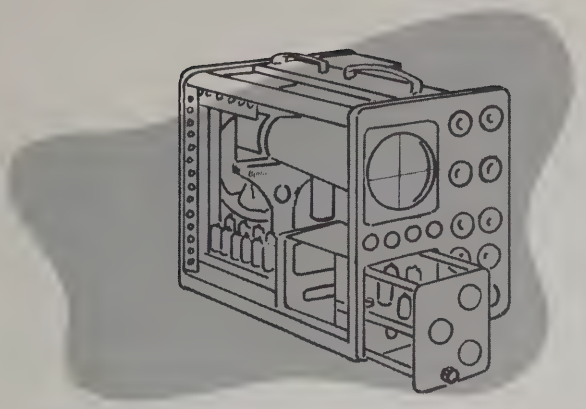
All wiring used in the G Unit is color coded to help circuit tracing. In addition filament and power-supply leads are known by specific color codes. All power supply leads follow the standard RETMA code. For example, the —150-volt lead is coded brown-green-brown. The widest stripe identifies the first color of the code. In general, all signal-carrying leads are white and coded with a single stripe.

Wires carrying positive regulated-power-supply voltages are white and the stripes indicate the supply voltage. The negative-supply bus wires are black and the stripes show the supply voltage.

The main-voltage leads to the power transformer are yellow and coded brown-brown-brown (1-1-1). The tube heater leads are white and coded 6-1, 6-2, 6-3, etc., not to indicate that the voltages are different but to differentiate between circuits.

Before attempting any troubleshooting work, you should check all the front panel controls for proper settings. If all controls are set properly, insure that the oscilloscope is known to be in correct adjustment.

CALIBRATION PROCEDURE



TEKTRONIX SCOPES AND CONTROL SETTINGS FOR CALIBRATION SETUP

The following control settings are used unless notice is given that other settings are used.

STABILITY: All of these controls are PRESET.

TIME/CM: All are at 1 millisecond.

INPUT SELECTOR: A or B DC.

Either the MAGNIFIER is OFF or the MULTIPLIER is 1. Tektronix Type 105 Square-Wave Generator: It is preferred that a 52-ohm cable be terminated with the Input-Capacitance-Standardizer, (CS 47).

TEK PLUG-IN PREAMP TYPE OSCILLOSCOPE	HORIZONTAL DISPLAY	TRIGGER MODE	TRIGGER SLOPE
531 and 541	Internal Sweep	Automatic	—Int
531A and 541A	Normal	Auto	—Int
532	Internal Sweep	Automatic	—Int
533 and 543	Normal (X 1)	Automatic	—Int
535 and 545	Main Sweep Normal	Automatic	—Int
535 and 545A	A or B	Auto	—Int
551	Normal	AC Auto	—Upper or —Lower
555	A x 1* or B x 1*	AC Auto	—Upper or —Lower
581**	Normal Sweep		—Int
585**	A or B		—Int

*SWEEP FUNCTION is Normal.

**Adapted for Letter Units with Type 81.

The Type 536 is calibrated with Time-Base Unit Type T plugged into the horizontal amplifier position or with the G Unit placed in another Tektronix Plug-In Preamp Type Oscilloscope.

INTRODUCTION

Information contained in this section of the manual is provided as an aid to calibrating and checking the operation of the Type G Plug-In Unit. In addition, this section may be used as an aid to isolating troubles occurring in the unit..

There are four of the most common adjustments to be made included in the Operation Procedure, Section 2. These adjustments for the DIFFerential BALANCE control, GAIN ADJUST, DC BALANCE, and the VERTical POSition RANGE controls are placed in this section for convenience to the operator during normal operational procedure. If any difficulty arises, the manual suggests going through the calibration procedure in its entirety.

Apparent troubles in the unit are occasionally the result of improper calibration of one or more circuits. Consequently, calibration checks should be an integral part of any troubleshooting procedure. Abnormal indications occurring during calibration checks will often aid in isolating troubles to a definite circuit or stage.

In the instructions that follow, the steps are arranged in the proper sequence for a complete calibration of the unit. Each numbered step contains the information required to make one check or adjustment. The steps are arranged to avoid unnecessary repetition of checks or adjustments.

In each calibration step only the required information is given. Detailed instructions pertaining to normal operation of the instrument are not included. If you are in doubt as to the proper operation of controls, refer to the Operating Information section of this manual.

Most adjustments are accessible when the cabinet panels or side and bottom panels are removed from the scope into which the unit is plugged. However, the EP53 or EP54 Plug-In Extension is obtainable from the factory to make adjustments easier. (Part No. 013-019).

Plug the unit into an oscilloscope and turn the power on. Wait about 5 minutes for the initial warm-up drift to cease. Free-run the oscilloscope sweep at some convenient rate so a trace is visible on the crt face.

EQUIPMENT REQUIRED

The following equipment or its equivalent is required to perform a complete calibration of the Type G Plug-In Unit.

1. 1 Tektronix Type 530-, Type 540-, or Tektronix plug-in wide-band oscilloscope. This scope must be properly calibrated.

2. Tektronix Type 105 Square-Wave Generator or equivalent. If the Type 105 is not available, the substitute must have a risetime of no more than 5 ns, and output frequencies of 1 kc, 100 kc and 500 kc.

3. 1 Tektronix Type 190 or 190A, Constant-Amplitude Signal Generator, or its equivalent. If the Type 190 is not available,

it will be necessary to substitute a generator that provides 2 volts signal with a frequency of 20 mc.

4. 1 Input-Capacitance-Standardizer (CS 47) Tektronix Part No. 011-030.

5. 2 of 52 ohm terminating resistor or 2 of 93 ohm terminating resistor. Type B52-R or B93-R.

6. 2 of 52 ohm coax cable or 2 of 93 ohm cable.

7. 1 of Special Dual-Input Connector (a coax tee) Tektronix Part No. 003-036. See Figure 5-1.

8. 2 of equivalent value coax cables having short length, such as 6". These two short cables must be of equal length, because a difference in length of less than one-half inch introduces a noticeable phase difference at 20 mc.

NOTICE: All of these coax cables and the terminating networks must have the same value. Using a 93 ohm cable necessitates using the 93 ohm terminating resistors. The two short cables used in conjunction with the dual-input connector for the differential balance adjustment must also be 93 ohm in value. The Type 105 Square-Wave Generator can be terminated in 52 or 93 ohms. For a faster risetime, the 52 ohm cable network is the best connector. Which value you use is not as important as the fact that all the connectors *must* be of the same value.

9. One of 5:1 or 10:1 "L" pad; 52 ohm or 93 ohm.

10. Low-Capacitance Recalibration Tool (Part No. 003-000 or 003-001).

Suggested Equipment

The EP53 or EP54 Plug-In Extension will permit easier adjustment of attenuators by allowing the plug-in to operate outside the scope. See Figure 5-2.

Adjustment Procedure

The following outline is based on the adjustment procedure we use in our own test department at the factory. Ordinarily, adjustments in the field will be limited to touching up some of the dc and balancing controls as found on pages 2-3 through 2-4 in the Operating Instructions section of this manual. However, if readjustment of the transient response is necessary, a certain order of events must be maintained. The DIFFerential-BALance, GAIN ADJUST, VERTical POSition RANGE, and DC BALANCE adjustments should be followed as outlined each time a tube is changed and before continuing with the following outline for a complete recalibration.

If this unit is to be used only in the 530-Series Oscilloscopes, the peaking coils should not be adjusted. The effect of these coils can only be seen when the unit is used in the 540-Series or other fast-risetime scopes.

Recheck the four adjustments before continuing the complete calibration procedure.

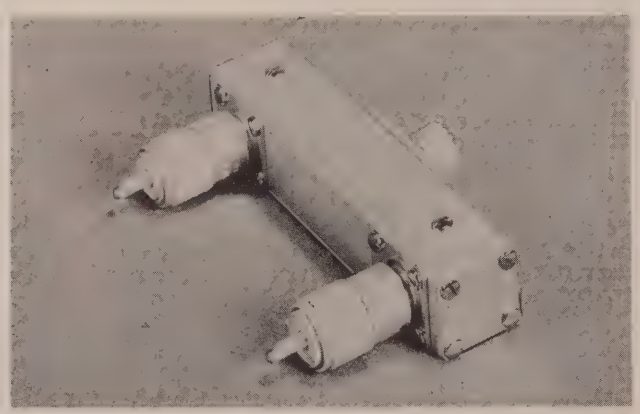


Fig. 5-1. Special Dual-Input Coax Connector.

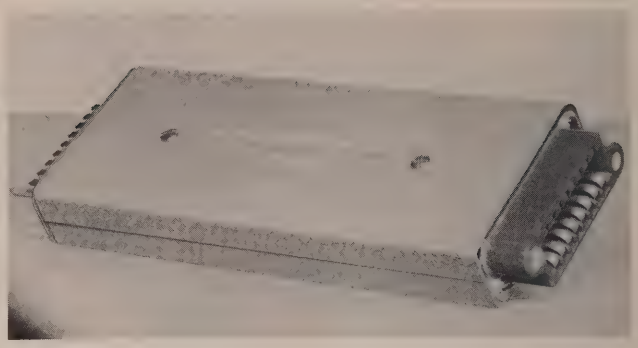


Fig. 5-2. EP54 Plug-In Extension.

Divider Compensation (S/N 101-1000)

If the Plug-In Extension (EP53 or EP54) is being used to make this adjustment, a shield should be placed over the Type G Unit to simulate chassis capacitance.

Connect a Tektronix Type 105 Square-Wave Generator to INPUT A using a 5:1 or 10:1 L pad. Set the VOLTS/CM switch to the .05 position. Set the square-wave generator to 100 kc and adjust the amplitude for three or four centimeters of deflection. Adjust C3857 for a flat top on the square wave and C3867 (see Figure 5-4) for a square corner. These adjustments interact, so readjustment may be necessary to get the best square wave (see Figure 5-3).

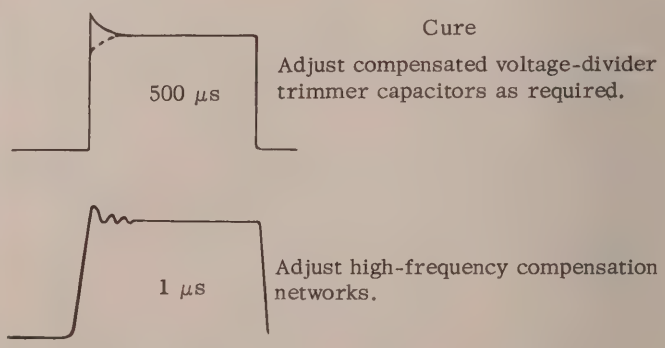


Fig. 5-3. Waveform Distortion Display.

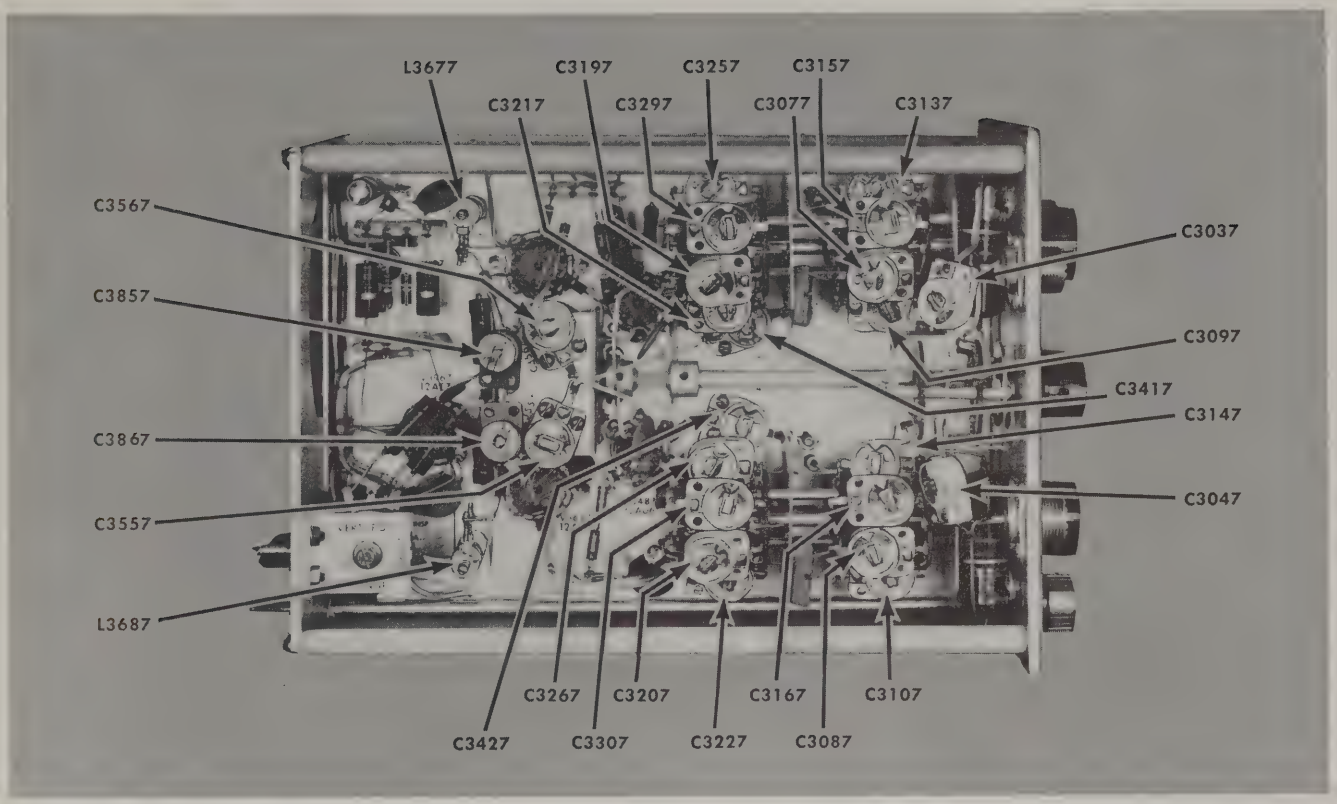


Fig. 5-4. Left side view showing adjustment points (through S/N 1000).

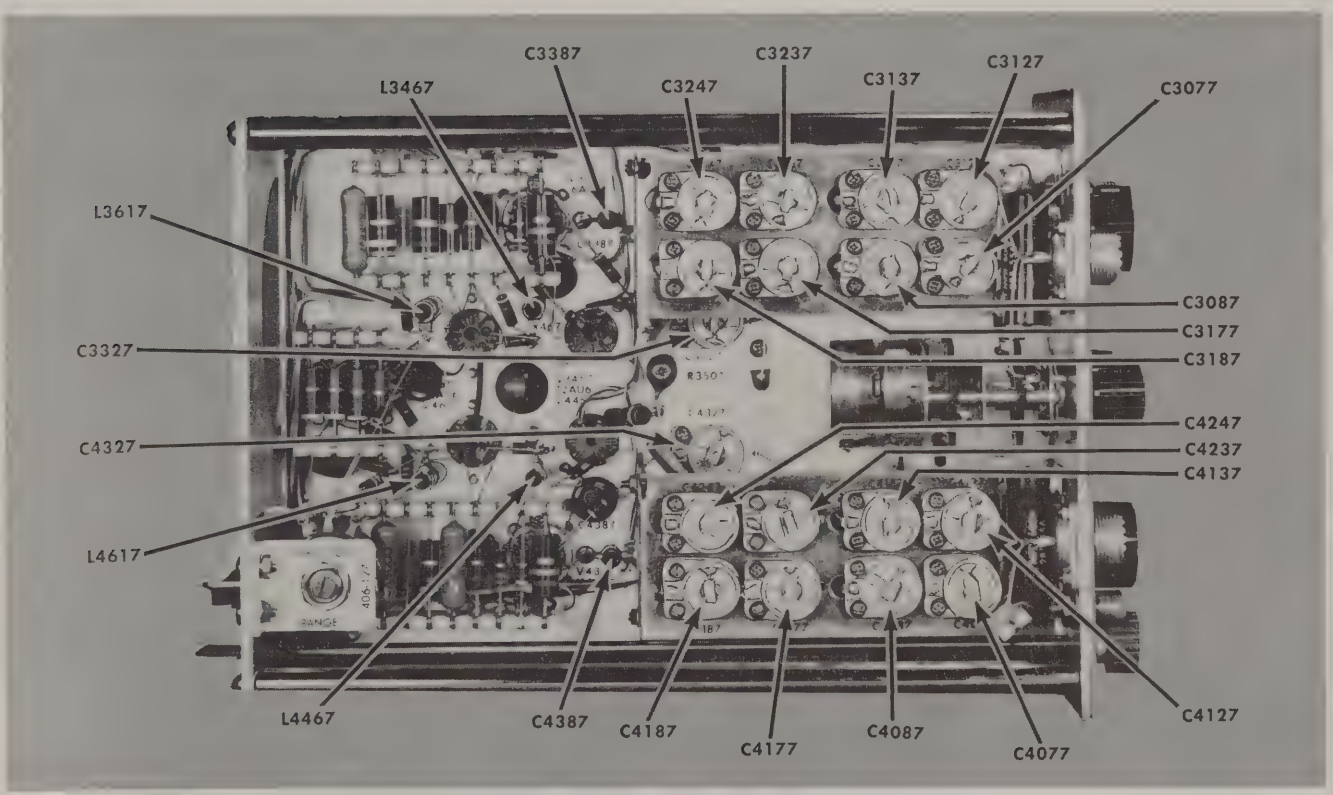


Fig. 5-5. Left side view showing adjustment points (S/N 1001-up).

Neutraliation Adjustment (S/N 101-1000)

Turn the INPUT SELECTOR switch to A-B. Set both VOLTS/CM switches to .05. Apply a .2-volt square-wave from the oscilloscope calibrator, to INPUT A. Set the sweep speed to see four or five cycles. Adjust C3567 for a square corner on the waveform, or so there is no change as the INPUT SELECTOR switch is switched to A.

Next apply the square wave to INPUT B and adjust C3557 for a square corner on the square wave, or so there is no change as the INPUT SELECTOR switch is switched to —B.

Input Attenuator Adjustments

The need for adjustment of the input attenuators is determined by observing the response to a 1-kc square wave. There are two types of adjustments to be made. One is to compensate the attenuators so the ac attenuation is equal to the dc attenuation. This involves a moderately short time constant. It can be recognized as a slight rounding or overshoot of the leading corner of the 1-kc square wave. The other type of adjustment is to set the input capacitance equal in all positions of the attenuator. This regulation is necessary if there is a downward or upward slope of the first one-half of the square wave.

Most Tektronix plug-in units are regulated to have a standard input capacitance of 47 $\mu\mu$f. This makes the probes interchangeable between units without readjustments. To keep this feature, you will need to use the CS-47 Input-Capacitance-Standardizer or to standardize a probe.

To standardize a probe, plug it into a unit that you know to be properly calibrated and observe the calibrator waveform. Adjust the trimmer in the probe for a flat top on the waveform such as seen in Figure 5-3. Another way is to use a Tektronix Type 130 L-C Meter to set the input capacitance at the standard 47 $\mu\mu$f in the .05 position of the VOLTS/CM switch. Then adjust the probe in this position to standardize the probe. This probe can then be used where the text calls for the Input Capacitance Standardizer.

A short risetime square-wave generator, such as the Tektronix Type 105 gives the best results when making the attenuator compensation. The calibrator waveform gives an inexact adjustment because it has a relatively long risetime. This long risetime makes it easy to overcompensate the attenuator.

Attach the standard probe or Input Capacitance Standardizer to INPUT A and connect it to the square-wave generator. Set the generator to 1 kc and the INPUT SELECTOR switch to the A (DC) position. View five or six cycles on the crt screen.

Adjust the capacitors (see Figures 5-4 and 5-5) listed in the following table with the VOLTS/CM switch in the position shown. Adjust each attenuator network for the squarest corner and the flattest top on the square wave.
NOTE: The adjustment for the square corner from S/N 1585 up is made with the standardizer removed. The signal is properly terminated at the connector for INPUT A.

Input A Adjustment

VOLTS/CM	FLAT TOP		
	SN101-1000	SN1001-1584	SN1585-up
.05	C3037	**C3037	C3327
.1	C3257	C3237	C3237
.2	C3197	C3177	C3177
.5	C3137	C3127	C3127
5	C3077	C3077	C3077

VOLTS/CM	SQUARE CORNER		
	SN101-1000	SN1001-1584	*SN1585-up
.05			
.1	C3297	C3247	C3247
.2	C3217	C3187	C3187
.5	C3157	C3137	C3137
5	C3097	C3087	C3087

* Standardizer is removed and signal from Square-wave generator is terminated properly at INPUT A connector.

** From SN 1473-1585 both C3327 and C3037 are adjusted for a flat top.

Input B Adjustment

INPUT B Adjustments are made with the same equipment attached to INPUT B, and the same conditions prevail.

VOLTS/CM	FLAT TOP		
	SN 101-1000	SN 1001-1584	SN1585-up
.05	C3047	**C4037	C4327
.1	C3267	C4237	C4237
.2	C3207	C4177	C4177
.5	C3147	C4127	C4127
5	C3087	C4077	C4077

VOLTS/CM	SQUARE CORNER		
	SN101-1000	SN1001-1584	*SN1585-up
.05			
.1	C3307	C4247	C4247
.2	C3227	C4187	C4187
.5	C3167	C4137	C4137
5	C3107	C4087	C4087

* Standardizer is removed and signal from Square-wave generator is terminated properly at INPUT B connector.

** From SN 1473-1585 both C4327 and C4037 are adjusted for a flat top.

Differential Compensation

The attenuators are adjustable to within very close limits by this differential adjustment. This is a very critical adjustment. It should be made when there is a spike greater than one-half centimeter on the resulting waveform of a square wave connected differentially into the plug-in unit. Be careful that you don't overcompensate one attenuator for the fault of the other. You can check each attenuator individually by displaying the inputs individually and observing which input needs compensation.

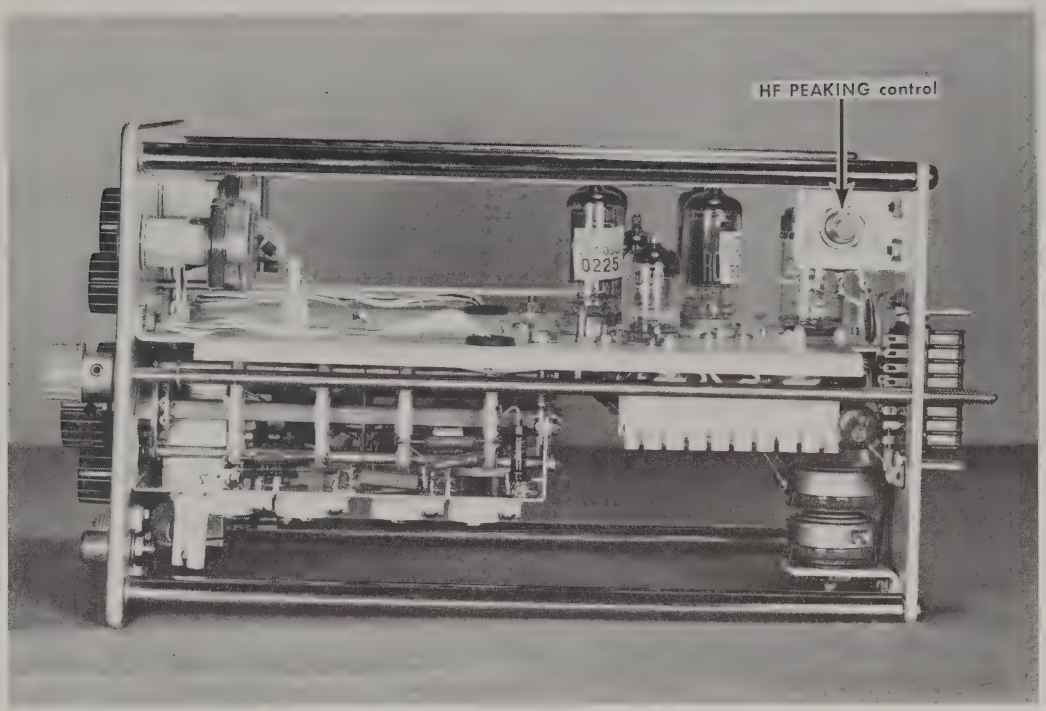


Fig. 5-6. HF Peaking control on chassis bottom (S/N 1001-up).

Check the DIFF. BALance, GAIN ADJUST, DC BALance, and VERT. POSITION adjustments as on Page 2-3, Operating Instructions.

Set both VOLTS/CM switches to .05 and the INPUT SELECTOR switch to A-B. Connect the oscilloscope calibrator to both inputs. Set the calibrator to deliver 2 volts signal. Move both VOLTS/CM switches to the positions shown below and switch the calibrator to the voltage listed. If there is a spike on the resulting waveform which exceeds one-half centimeter, adjust the listed capacitors very slightly to reduce this spike. The square wave that remains in some positions is caused by a slight unbalance in the 1% tolerance attenuator resistors.

VOLTS/CM	CAL. VOLTS	CAPACITOR	
		TO S/N 1000	S/N 1001
.1	5	C3297 C3307	C3247 C4247
.2	10	C3217 C3227	C3187 C4187
.5	20	C3157 C3167	C3137 C4137
5	100	C3097 C3107	C3087 C4087

Peaking Coils

If this unit is used in 530-Series Oscilloscopes only, the peaking coils should not be adjusted. The effect of these peaking coils can only be seen when the unit is used in 540-Series Oscilloscopes or other fast risetime scopes.

For peaking coil adjustments, the scope with the Type G Unit must have had a 5-minute warm-up drift time allowed. Turn the VOLTS/CM switch to .05 and the VARIABLE VOLTS/CM control to the CALIBRATED position. Connect the Tektronix Type 105 to INPUT A using a 5:1 or 10:1 L pad. Display one or two cycles of a 250- to 500-kc square wave (500 kc for S/N 101-1000) with two to three centimeters deflection (three to four centimeters, up to S/N 1000).

The peaking coils affect the rise and leading corner of the square wave. They should be adjusted for a square corner with no overshoot. (See Figure 5-4). These controls are interacting so you must readjust them as necessary to keep the flattest top possible. Slugs should be set to about the same position, so that overcompensation does not exist on one section and an imbalance result.

Preset the HF PEAKING control (S/N 1001-up) counterclockwise. Adjust L3617 and L4617 (L3677 and L3687, through S/N 1000) and then adjust L3467 and L4467 (S/N 10001-up) for the square corner with no overshoot.

The HF PEAKING control affects the leading edge only. Adjust this control (S/N 1001-up) to get a sharp corner on the waveform. (See Figure 5-6).

High-Frequency Differential Balance

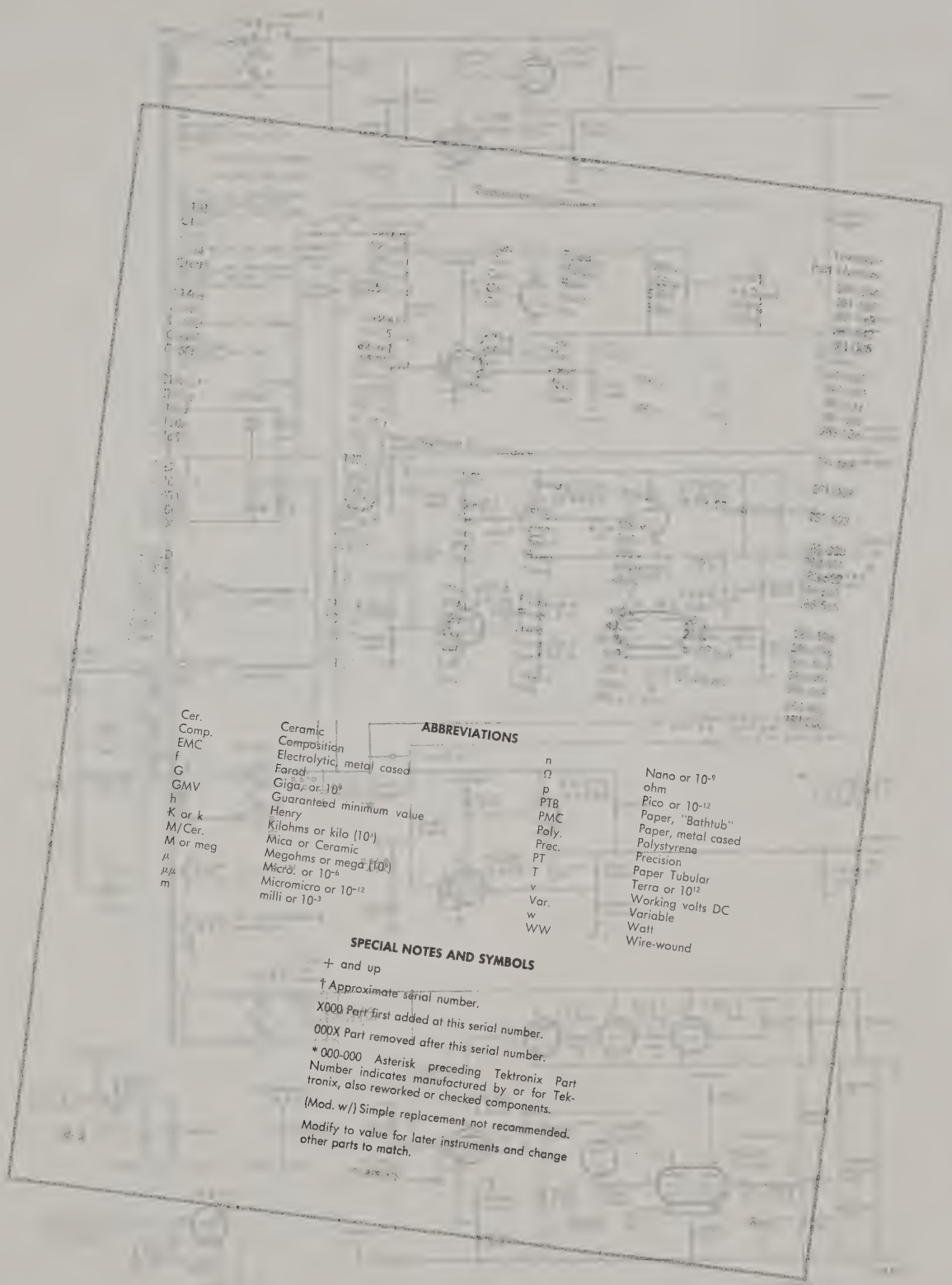
Connect the signal generator to both inputs of the Type G Plug-In Unit. Through S/N 1000, use the Tektronix Type 105 Square-Wave Generator that is set for 1 kc signal. From S/N 1001-up, the signal generator should be a sine-wave generator, such as the Tektronix Type 190. This is set for 20 mc.

The length of the signal path should be the same to avoid a phase difference in the two signals. At the factory, we connect the signal generator to a coax tee. (See Figure 5-1). To this tee, we connect two six-inch coax cables. Each cable is terminated in identical values to correspond with the value of the coax cable. The accuracy of these equivalent terminations can be checked. This is done by reversing the inputs into which they are connected, after the high-frequency differential-balance adjustment is completed. If these terminations are not identical, you will not have perfect differential balance.

Set the INPUT SELECTOR switch to the AC position of the A—B differential balance. Both VOLTS/CM switches are in the .05 settings. Set the Type 190 generator (S/N 1001-up) to 20 mc and an amplitude of 2 volts. Through S/N 1000, set the Type 105 generator to 1 kc with an amplitude of 2 volts. The amplitude can be determined by switching the INPUT SELECTOR switch to A and the "A" VOLTS/CM switch to .5. Through S/N 1000, recheck the adjustment of the front-panel DIFFerential BALance control. See table for adjutments.

ADJUST		
SN 101-1000	SN 1001-1472	SN 1473-up
C3417	C3327	C3387
C3427	C4327	C4387

PARTS LIST *and* DIAGRAMS



ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^{9}	PMC	Paper, metal cased
GMV	Guaranteed minimum value	Poly.	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^{3})	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^{6})	v	Working volts DC
μ	Micro, or 10^{-6}	Var.	Variable
μμ	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

\+ and up

† Approximate serial number.

X000 Part first added at this serial number.

000X Part removed after this serial number.

* 000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

TEKTRONIX

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

HOW TO ORDER PARTS

Replacement parts are available from or through your local Tektronix Field Office.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Field Office will contact you concerning any change in part number.

PARTS LIST

Capacitors

Values fixed unless marked Variable.
Tolerance ±20% unless otherwise indicated.

Ckt. No.	S/N Range	Description					Tektronix Part Number
C3017	101-1000	.1 μf	PTM		600 v		Use *295-054
C3027	101-1000X	.1 μf	PTM		600 v		
C3017	1001-up	.1 μf	PT		600 v		*295-054
		C3017 and C4017 paired to 1% of each other, furnished as a unit.					
C3037	101-1584X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3047	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3067	X1842-up	8 μμf	Cer.	Var.	500 v	±0.5%	281-503
C3077	101-561	3-12 μμf	Cer.	Var.	500 v		281-007
	562-1000	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1001-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C3087	101-561	3-12 μμf	Cer.	Var.	500 v		281-007
	562-up	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3097	101-1000	5-20 μμf	Cer.	Var.	500 v		Use 281-010
	1001-up	250 μμf	Mica		500 v	5%	283-543
C3107	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3117	101-1000X	.002 μf	Mica		500 v	5%	283-529
C3127	101-1000	.002 μf	Mica		500 v	5%	283-529
	1001-1584	3-12 μμf	Cer.	Var.	500 v		281-007
	1585-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C3137	101-1000	3-12 μμf	Cer.	Var.	500 v		281-007
	1001-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C3147	101-1000	3-12 μμf	Cer.	Var.	500 v		281-007
	1001-up	100 μμf	Cer.		500 v	10%	281-530
C3157	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3167	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3177	101-1000	150 μμf	Mica		500 v	10%	283-508
	1001-1584	3-12 μμf	Cer.	Var.	500 v		281-007
	1585-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C3187	101-1000	150 μμf	Mica		500 v	10%	283-508
	1001-up	3-12 μμf	Cer.	Var.	500 v		281-007
C3197	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3207	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3217	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3227	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3237	101-385	39 μμf	Cer.		500 v	10%	281-517
	386-1000	27 μμf	Cer.		500 v	10%	281-512
	1001-1584	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1585-up	3-12 μμf	Cer.	Var.	500 v		281-007
C3247	101-385	39 μμf	Cer.		500 v	10%	281-517
	386-1000	27 μμf	Cer.		500 v	10%	281-512
	1001-up	4.5-25 μμf	Cer.	Var.	500 v	10%	281-010
C3257	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
	X1842-up	8 μμf	Cer.		500 v	±0.5%	281-503

Capacitors *(continued)*

							Tektronix Part Number
C3267	101-1000	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1001-up	270 μμf	Cer.	Var.	500 v	10%	281-543
C3277	101-1000X	10 μμf	Cer.		500 v	10%	281-504
C3287	101-1000X	10 μμf	Cer.		500 v	10%	281-504
C3297	101-1000X	5-20 μμf	Cer.		500 v		Use 281-010
C3307	101-1000X	5-20 μμf	Cer.	Var.	500 v		Use 281-010
C3317	X1001-up	.01 μf	Cer.		500 v	GMV	283-002
C3327	X1001-1584	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1585-1767	3-12 μμf	Cer.	Var.	500 v		281-007
	1768-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C3367	X1001-up	.005 μf	Cer.		500 v		283-001
C3387	X1473-1584	.5-5 μμf	Tub.	Var.	350 v		281-001
	1585-up	.7-3 μμf	Tub.	Var.	350 v		281-027
C3397	101-1692X	.01 μf	Cer.		500 v		283-002
C3407	101-1000X	.01 μf	Cer.		500 v		283-002
C3417	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3427	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3457	X1001-up	.01 μf	Cer.		500 v	GMV	283-002
C3507	101-1000X	6.25 μf	EMT		300 v		Use 290-000
C3517	101-1000X	.01 μf	Cer.		500 v	GMV	283-002
C3527	101-1000X	.01 μf	Cer.		500 v	GMV	283-002
C3557	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3567	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C3857	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-006
C3867	101-1000X	1.5-7 μμf	Cer.	Var.	500 v		281-006
C3947	101-1000X	.01 μf	Cer.		500 v	GMV	283-002
C3977	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C3987	101-1000X	.01 μf	Cer.		500 v	GMV	283-002
C4017	X1001-up	.1 μf	MT		600 v		*295-054
		C4017, C3017 paired to 1% of each other, furnished as a unit.					
C4037	X1001-1584X	1.5-7 μμf	Cer.	Var.	500 v		281-005
C4067	X1842-up	8 μμf	Cer.		500 v	±0.5%	281-503
C4077	X1001-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C4087	X1001-up	1.5-7 μμf	Cer.	Var.	500 v		281-005
C4097	X1001-up	250 μμf	Mica		500 v	5%	283-543
C4127	X1001-1584	3-12 μμf	Cer.	Var.	500 v		281-007
	1585-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C4137	X1001-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C4147	X1001-up	100 μμf	Cer.		500 v	10%	281-530
C4177	X1001-1584	3-12 μμf	Cer.	Var.	500 v		281-007
	1585-up	4.5-25 μμf	Cer.	Var.	500 v		281-010
C4187	X1001-up	3-12 μμf	Cer.	Var.	500 v		281-007
C4237	X1001-1584	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1585-up	3-12 μμf	Cer.	Var.	500 v		281-007
C4247	X1001-up	4.5-25 μμf	Cer	Var.	500 v		281-010
C4257	X1842-up	8 μμf	Cer.		500 v	±0.5%	281-503
C4267	X1001-up	270 μμf	Cer.		500 v	10%	281-543
C4317	X1001-up	.01 μf	Cer.		500 v		283-002
C4327	X1001-1584	1.5-7 μμf	Cer.	Var.	500 v		281-005
	1585-1767	3-12 μμf	Cer.	Var.	500 v		281-007
	1768-up	4.5-25 μμf	Cer.	Var.	500 v		281-010

Capacitors *(continued)*

							Tektronix Part Number
C4367	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C4387	X1473-1584	.5-5 μμf	Tub.	Var.	500 v		281-001
	1585-up	.7-3 μμf	Tub.	Var.	350 v		281-027
C4457	X1001-up	.01 μf	Cer.		500 v	GMV	283-002
C4977	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C4987	X1001-up	.01 μf	Cer.		500 v	GMV	283-002
C4997	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C5007	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C5017	X1001-up	.005 μf	Cer.		500 v	GMV	283-001
C5027	X1001-up	.01 μf	Cer.		500 v	GMV	283-002

Inductors

L3457	X1001-up	.45 μh			*108-062
L3467	X1001-up	2.3-3.9 μh	Var.	core 276-506	*114-057
L3477	101-1000X	.75 μh			*108-072
L3487	101-1000X	.75 μh			*108-072
L3617	X1001-up	2.3-3.9 μh	Var.	core 276-506	*114-057
L3677	101-1000X	2.2-4.4 μh	Var.	core 276-503	*114-007
L3687	101-1000X	2.2-4.4 μh	Var.	core 276-503	*114-007
L3957	101-1000X	.45 μh			*108-062
L3967	101-1000X	.45 μh			*108-062
L3977	X1001-up	.18 μh			*108-009
L4457	X1001-up	.45 μh			*108-062
L4467	X1001-up	2.3-3.9 μh	Var.	core 276-506	*114-057
L4617	X1001-up	2.3-3.9 μh	Var.	core 276-506	*114-057
L4977	X1001-up	.18 μh			*108-009

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R3037	101-1000	27 Ω	½ w				302-270
	1001-up	15 Ω	½ w				302-150
R3047	101-1000X	27 Ω	½ w				302-270
R3057	101-1000X	47 Ω	½ w				302-470
R3067	101-1000X	47 Ω	½ w				302-470
R3087	X1001-up	990 k	½ w		Prec.	1%	309-013
R3097	101-1000	990 k	½ w		Prec.	1%	309-013
	1001-up	10.1 k	½ w		Prec.	1%	309-034
R3107	101-1000X	990 k	½ w		Prec.	1%	309-013
R3117	101-1000X	10.1 k	½ w		Prec.	1%	309-034
R3127	101-1000X	10.1 k	½ w		Prec.	1%	309-034
R3137	X1001-up	900 k	½ w		Prec.	1%	309-111
R3147	X1001-up	111 k	½ w		Prec.	1%	309-046
R3157	101-1000X	900 k	½ w		Prec.	1%	309-111
R3167	101-1000	900 k	½ w		Prec.	1%	309-111
	1001-up	27 Ω	½ w				302-270

							Tektronix Part Number
R3177	101-1000X	111 k	½ w		Prec.	1%	309-046
R3187	101-1000	111 k	½ w		Prec.	1%	309-046
	1001-up	750 k	½ w		Prec.	1%	309-010
R3197	X1001-up	333 k	½ w		Prec.	1%	309-053
R3217	101-1000X	750 k	½ w		Prec.	1%	309-010
R3227	101-1000X	750 k	½ w		Prec.	1%	309-010
R3237	101-1000X	333 k	½ w		Prec.	1%	309-053
R3247	101-1000	333 k	½ w		Prec.	1%	309-053
	1001-up	500 k	½ w		Prec.	1%	309-003
R3257	X1001-up	1 meg	½ w		Prec.	1%	309-014
R3267	X1001-up	22 Ω	½ w				302-220
R3277	101-1000X	500 k	½ w		Prec.	1%	309-003
R3287	101-1000X	500 k	½ w		Prec.	1%	309-003
R3297	101-1000X	1 meg	½ w		Prec.	1%	309-014
R3307	101-1000	1 meg	½ w		Prec.	1%	309-014
	1001-up	1 meg	½ w		Prec.		*312-583
		R3307, R4307 paired ±. 1%, furnished as a unit.					
R3317	X1001-up	100 k	½ w				302-104
R3357	X1001-up	47 Ω	½ w				302-470
R3367	X1001-up	47 Ω	½ w				302-470
R3377	101-1000X	1 meg	½ w		Prec.	1%	309-014
R3387	101-1000	1 meg	½ w		Prec.	1%	309-014
	1001-1691	39 k	1 w			5%	303-393
	1692-up	27 k	2 w			5%	305-273
R3397	101-1000	390 k	½ w				302-394
	1001-1691X	27 k	2 w				304-273
R3407	101-1000X	390 k	½ w				302-394
R3417	101-1000X	47 Ω	½ w				302-470
R3427	101-1000X	47 Ω	½ w				302-470
R3447	101-1000X	10 k	5 w		WW	5%	308-054
R3457	X1692-up	8.2 k	1 w				304-822
R3467	X1001-up	470 Ω	½ w			5%	301-471
R3477	101-365	470 Ω	½ w				302-471
	366-1691X	470 Ω	½ w			5%	301-471
R3487	101-365	470 Ω	½ w				302-471
	366-1000X	470 Ω	½ w			5%	301-471
R3507	101-1000	18 k	½ w				302-183
	1001-1472	8 k	5 w		WW	5%	308-007
	1473-1916	10 k	5 w		WW	5%	308-008
	1917-up	8 k	5 w		WW	5%	308-007
R3517	101-1000	3.3 k	½ w				302-332
	1001-up	3.9 k	1 w				304-392
R3527		3.3 k	½ w				302-332
R3537	101-1000	15 k	2 w	Var.		Diff. Bal.	311-045
	1001-up	3.3 k	½ w				302-332
R3547	101-1000	100 k	½ w				302-104
	1001-up	100 k	2 w	Var.		Diff. Bal.	311-026
R3557	X1001-up	100 k	½ w				302-104
R3567	X1001-up	3.3 k	½ w				302-332
R3577	101-1000X	47 Ω	½ w				302-470

							Tektronix Part Number
R3587	101-1000X	47 Ω	½ w				302-470
R3597	101-1000X	15 k	2 w				306-153
R3607	101-1000	15 k	2 w				306-153
	1001-up	4 k	5 w		WW	5%	308-051
R3617	X1001-up	470 Ω	½ w			5%	301-471
R3647	X1001-up	22 k	½ w				302-223
R3657	X1001-up	100 k	2 w	Var.		D.C. Bal	311-026
R3667	X1001-up	47 k	½ w				302-473
R3677	101-1000	680 Ω	½ w			5%	301-681
	1001-up	47 Ω	½ w				302-470
R3687	101-1000X	680 Ω	½ w			5%	301-681
R3707	X1001-up	5.6 k	1 w			5%	303-562
R3717	101-1000	1 k	2 w	Var.		Variable	311-006
	1001-up	880 Ω		Var.	WW		Use *311-285
R3727	101-1000	500 Ω	1/10 w	Var.		Gain Adj.	311-056
	1001-up	5.6 k	1 w			5%	303-562
R3737	101-365	18 k	2 w				306-183
	366-1000	22 k	2 w				306-223
	1001-up	10 k	5 w		WW	5%	308-054
R3747	101-365	18 k	2 w				306-183
	366-1000	22 k	2 w				306-223
	1001-1916	10 k	2 w	Var.	WW	Gain Adj.	311-015
R3747A,B	1917-up	10 k x 5 k	2 w	Var.	WW	Gain Adj.	311-101
R3767	101-365	2 k	2 w	Var.		DC Bal	311-008
	366-1000X	100 k	2 w	Var.		DC Bal.	311-026
R3777	X366-1000X	47 k	½ w				302-473
R3797	101-1000X	100 k	½ w				302-104
R3807	101-1000	100 k	½ w				302-104
	1001-1691	6.8 k	2 w				306-682
	1692-up	4.7 k	2 w				306-472
R3817	X1001-1691	10 k	½ w				302-103
	1692-up	4.7 k	1 w				304-472
R3827	101-1000X	2 x 100 k	2 w	Var.		Vertical Position	311-028
R3847	X1001-up	100 k	½ w				302-104
R3857	101-1000	143 k	1 w		Prec.	1%	310-088
	1001-up	2 x 100 k	2 w	Var.		Vertical Position	311-028
R3867	101-1000X	143 k	1 w		Prec.	1%	310-088
R3877	101-1000	200 k	1 w		Prec.	1%	310-051
	1001-up	100 k	½ w				302-104
R3887	101-1000	200 k	1 w		Prec.	1%	310-051
	1001-up	2 x 100 k	2 w	Var.		Vert. Pos. Range	311-051
R3907	101-1000X	5 k	2 w	Var.		Vert. Pos. Range	311-049
R3917	101-1000X	47 Ω	½ w				302-470
R3927	101-1000X	47 Ω	½ w				302-470
R3937	X1001-up	3.9 k	2 w				306-392
R3947	101-1000	3.3 k	2 w				306-332
	1001-up	9.1 k	1 w			5%	303-912

Resistors *(continued)*

							Tektronix Part Number
R3957	101-1000	6.8 k	2 w				306-682
	1001-up	47 Ω	½ w				302-470
R3967	101-1000X	6.8 k	2 w				306-682
R3977	X1001-up	9.1 k	1 w			5%	303-912
R3987	101-1000	84 Ω	5 w		WW	5%	308-056
	1001-up	2 k	2 w	Var.		H.F. Peaking	311-008
R4037	X1001-up	15 Ω	½ w				302-150
R4087	X1001-up	990 k	½ w		Prec.	1%	309-013
R4097	X1001-up	10.1 k	½ w		Prec.	1%	309-034
R4137	X1001-up	900 k	½ w		Prec.	1%	309-111
R4147	X1001-up	111 k	½ w		Prec.	1%	309-046
R4167	X1001-up	27 Ω	½ w				302-270
R4187	X1001-up	750 k	½ w		Prec.	1%	309-010
R4197	X1001-up	333 k	½ w		Prec.	1%	309-053
R4247	X1001-up	500 k	½ w		Prec.	1%	309-003
R4257	X1001-up	1 meg	½ w		Prec.	1%	309-014
R4267	X1001-up	22 Ω	½ w				302-220
R4307	X1001-up	1 meg	½ w		Prec.		*312-583
		R4037, R3307 paired ±.1%, furnished as a unit.					
R4317	X1001-up	100 k	½ w				302-104
R4357	X1001-up	47 Ω	½ w				302-470
R4367	X1001-up	47 Ω	½ w				302-470
R4387	X1001-1691	39 k	½ w			5%	303-393
	1692-up	27 k	2 w			5%	305-273
R4467	X1001-up	470 Ω	½ w			5%	301-471
R4617	X1001-up	470 Ω	½ w			5%	301-471
R4677	X1001-up	47 Ω	½ w				302-470
R4847	X1001-up	100 k	½ w				302-104
R4877	X1001-up	100 k	½ w				302-104
R4947	X1001-up	9.1 k	1 w			5%	303-912
R4957	X1001-up	47 Ω	½ w				302-470
R4977	X1001-up	9.1 k	1 w			5%	303-912
R5007	X1692-1916	6 k	5 w		WW	5%	Use 308-101
	1917-up	5.5 k	5 w		WW	5%	308-101
R5027	X1001-up	47 Ω	½ w				302-470

Switches

				Wired	Unwired
SW3017	X1001-up	Rotary	INPUT SEL.		*260-167
SW3027	101-1000X	Rotary	INPUT SEL.	*262-082	*260-092
SW3057	101-1000X	Rotary	VOLTS/CM A	*262-077	*260-091
SW3067	101-1000X	Rotary	VOLTS/CM B	*262-078	*260-091
SW3347	X1001-up	Rotary	VOLTS/CM A	Use *050-161	*260-166
SW4347	X1001-up	Rotary	VOLTS/CM B	Use *050-170	*260-166

Electron Tubes

V3347 †	X1001-1691	6BH6		154-026
	1692-2018	6AK5		Use *157-054
	2019-up	6AK5	Selected	*157-054

Electron Tubes *(continued)*

				Tektronix Part Number
V3457	*X1001-up	12AU6	Selected	Use *157-038
V3477	101-1000X	12AU6	Selected Pair	Use *157-038
V3487		12AU6		
V3617A,B	101-199	12AT7		Use 154-039D
	200-1000X	12AT7		154-039D
V3627A,B	101-199	12AT7		Use 154-039D
	200-1000X	12AT7		154-039D
V3657	**X1001-up	12AU6	Selected	Use *157-038
V3947	X1001-up	12AT7		154-039D
V3967	101-199	12AT7		Use 154-039D
	200-1000X	12AT7		154-039D
V4347 †	X1001-1691	6BH6		154-026
	1692-2018	6AK5		Use *157-054
	2019-up	6AK5	Selected	*157-054
V4457	*X1001-up	12AU6	Selected	Use *157-038
V4657	**X1001-up	12AU6	Selected	Use *157-038

*V3457, V4457 are a matched pair. Furnished as a unit.

**V3657, V4657 are a matched pair. Furnished as a unit.

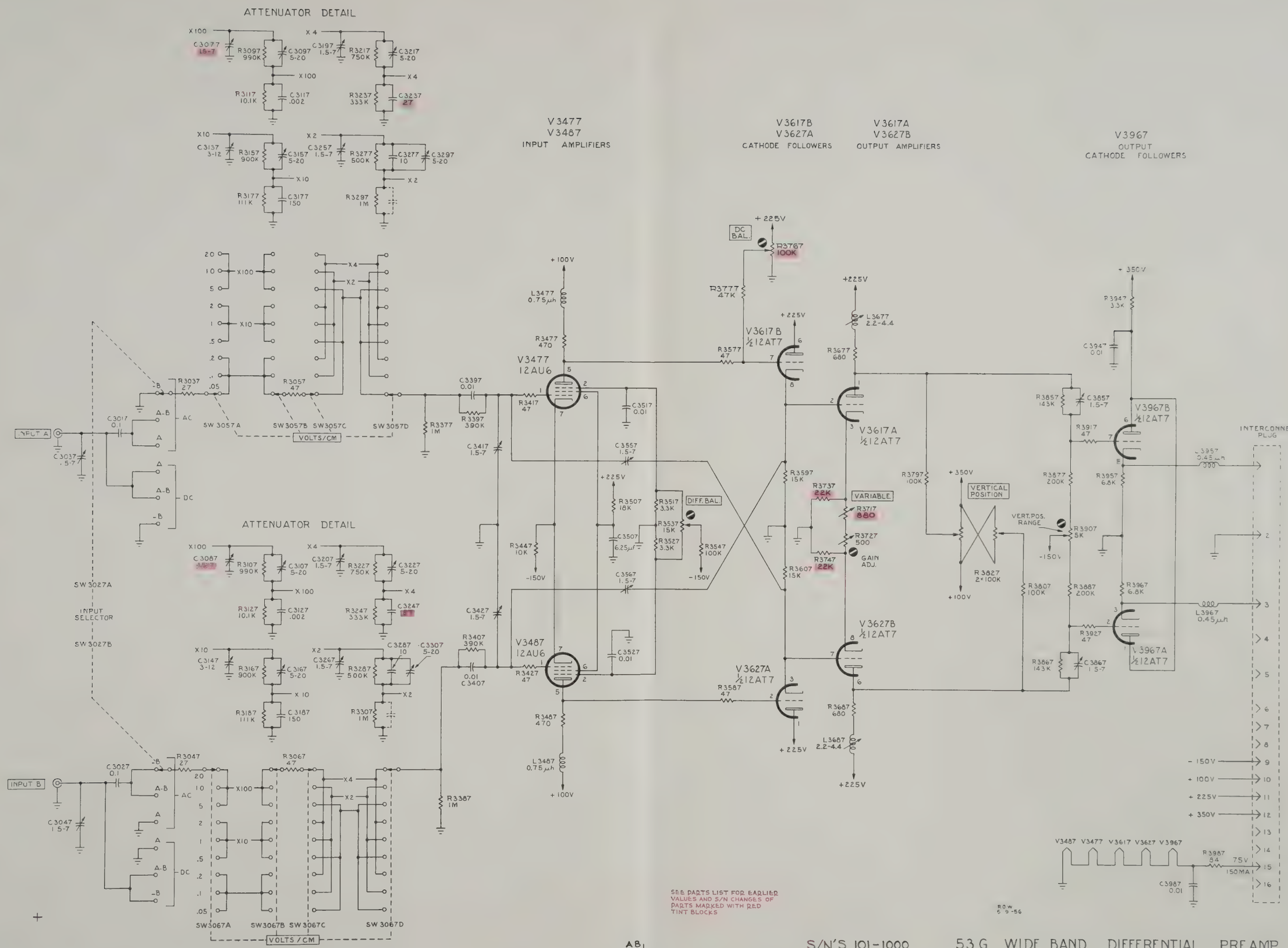
† V3347, V4347 SN/1692 and up furnished as a unit.

Type G
Mechanical Parts List

	Tektronix Part Number
BOLTS, SPADE, STEEL 6-32 x 7/8	214-013
BOLTS, SPADE, STEEL 4-40 x 1/2, w/hole drilled for #4 screw	214-045
BRACKET, ALUM., VERT. POS. RANGE POT	406-127
BRACKET, ALUM., HF PEAKING	406-186
BRACKET, ALUM., VOLTS/CM "A"	406-281
BRACKET, ALUM., VOLTS/CM "B"	406-282
BUSHING, ALUM., 3/8-32 x 9/16 x .412	358-010
CABLE, HARNESS	179-135
CAP, BINDING POST 3/8 OD x 11/32 x 1/4-28 thread	200-103
CHASSIS	441-144
CONNECTOR, CHASSIS MT. COAX 83-IRTY 101-9479	131-012
CONNECTOR, CHASSIS MT. COAX, BNC 9480-up	131-277
CONNECTOR, CHASSIS MT., AMPH. 26-159-16, 16-contact, male	131-017
EYELET, AM. BRASS., .190-.183 OD tapped barrel	210-601
FASTENER, SNAP .122 wide x 9/16 lg. w/2-.396 long prongs	214-153
GROMMET, RUBBER 3/8"	348-004
KNOB, LARGE BLACK 1.375 OD x .650 hi, 1/4 hole part way	366-042
KNOB, SMALL BLACK .780 OD x .591 hi, 1/4 hole part way	366-044
KNOB, SMALL BLACK .780 OD x .591 hi, 1/8 hole part way	366-045
KNOB, ALUM.	366-125
LOCKWASHER, STEEL EXT #2	210-002
LOCKWASHER, STEEL EXT #4	210-003
LOCKWASHER, STEEL INT #4	210-004
LOCKWASHER, STEEL INT #6	210-006
LOCKWASHER, STEEL INT 1/4	210-011
LOCKWASHER, STEEL POT INT 3/8 x 1/2	210-012
LOCKWASHER, STEEL INT 3/8 x 11/16	210-013
LOCKWASHER, INT. 1/4	210-046
LUG, SOLDER, SE4	210-201
NUT, HEX, BRASS, 2-56 x 3/16	210-405
NUT, HEX, BRASS, 4-40 x 3/16	210-406
NUT, HEX, BRASS, 6-32 x 1/4	210-407
NUT, HEX, BRASS, 3/8-32 x 1/2	210-413
NUT, HEX, ALUM. BUSHING BN 16-28, 3/8-32 x 1/2 x 1 1/16	210-429
NUT, HEX, STEEL 1/4-28 x 3/8 x 3/32	210-455
NUT, KEPS STEEL 6-32 x 5/16	210-457
NUT, HEX, ALUM., 6-32 x 5/16 x .194 body	210-478
PANEL, "G" WIDE BAND	333-514
PLATE, SUB PANEL	386-544

Mechanical Parts List *(continued)*

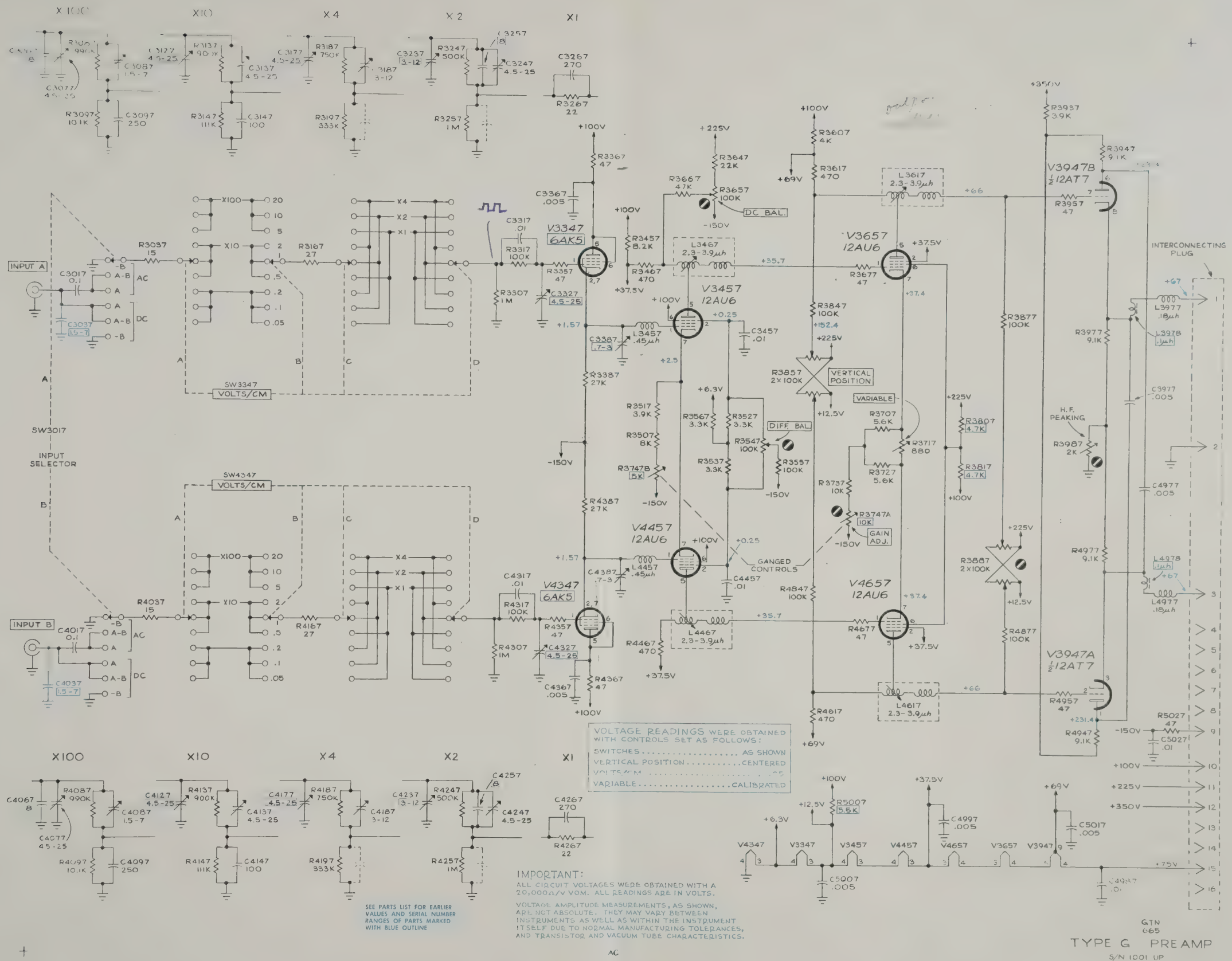
	Tektronix Part Number
PLATE, ALUM., .091 x 5-11/32 x 6-11/32 FP	387-529
POST, CONNECTING, CERAMIC 1/2", CP 1/2-5/16 stud	129-009
RING, RETAINING #18	354-025
RING, SPACING ALUM., .384 ID x 1/2 OD x 7/32	354-060
ROD, HEX, ALUM., 1/2 x 1 5/16, tap 3/8 x 32	*385-158
ROD, MISC., FRAME, 3/8 x 8 7/8, tapped 8-32 both ends	384-508
ROD, MISC., SECURING, 3/16 OD x 10 1/2, 10-24 thread one end	384-510
SCREW 4-40 x 1/4 BHS	211-008
SCREW 4-40 x 5/16 BHS	211-011
SCREW 4-40 x 5/16 Pan HS w/lockwasher	211-033
SCREW 4-40 x 5/16 FHS Phillips	211-038
SCREW 6-32 x 5/16 BHS	211-507
SCREW 6-32 x 3/8 BHS	211-510
SCREW 6-32 x 5/16 FHS 100° CSK Phillips	211-538
SCREW 6-32 x 3/4 Truss HS Phillips	211-544
SCREW 6-32 x 3/8 FHS 100° CSK Phillips	211-559
SCREW 8-32 x 3/8 FHS 100° Phillips	212-040
SCREW 8-32 x 1/2 FHS Phillips	212-043
SCREW 8-32 x 1/2 RHS Phillips	212-044
SCREW, THREAD CUTTING 4-40 x 5/16 RHS	213-034
SCREW, THREAD CUTTING 5-32 x 3/16 PHS	213-044
SCREW, THREAD FORMING 4-20 x 1/4 PHS	213-088
SOCKET, STM7	136-007
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
SPACER, NYLON 5/32	361-007
SPACER, NYLON 3/8	361-009
STEM, BINDING POST ADAPTER 3/8 x 13/16 Brass	355-507
STRIP, CERAMIC 3/4 x 2 notches, clip mounted	124-086
STRIP, CERAMIC 3/4 x 4 notches, clip mounted	124-088
STRIP, CERAMIC 3/4 x 9 notches, clip mounted	124-090
STRIP, CERAMIC 3/4 x 1 notches, clip mounted	124-100
WASHER, STEEL 5S x 9/32 x .025	210-801
WASHER, STEEL 6L x 3/8 x .032	210-803
WASHER, STEEL 8S x 3/8 x .032	210-804
WASHER, FIBER #10	210-812
WASHER, STEEL .390 ID x 9/16 OD x .020	210-840
WASHER, STEEL #2 flat .093 ID x 9/32 OD x .020 thick	210-850



AB1

S/N'S 101-1000

53G WIDE BAND DIFFERENTIAL PREAMP



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

SWITCHES ..... AS SHOWN
VERTICAL POSITION ..... CENTERED
VOLTS/CM ..... .05
VARIABLE ..... CALIBRATED

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

IMPORTANT:

ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM. ALL READINGS ARE IN VOLTS.

VOLTAGE AMPLITUDE MEASUREMENTS, AS SHOWN, ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES, AND TRANSISTOR AND VACUUM TUBE CHARACTERISTICS.

GTN 665

TYPE G PREAMP

S/N 1001 UP

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE G

PARTS LIST CORRECTIONS

ADD:

L3978[1]	Bead, Ferrite	276-0528-00
L4978[2]	Bead, Ferrite	276-0528-00

[1]Added on the lead of L3977 which connects to the cathode of V3947.

[2]Added on the lead of L4977 which connects to the cathode of V3947.